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EXPERIMENTAL RESEARCH AND EMPIRICAL TESTING
OF DISTRIBUTED GROUP DECISION
SUPPORT SYSTEMS

by

Cindy Clark
and
R. Warren Miller

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Thesis Advisor: James E. Suchan

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Experimental Research and Empirical Testing of Distributed Group Decision Support Systems

by

Cindy Clark
Lieutenant, United States Navy
B.S., Jacksonville University, 1981

and

R. Warren Miller
Lieutenant, United States Navy
B.S., Adams State College, 1981

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ABSTRACT

Past research in the area of Group Decision Support Systems (GDSS) has attempted to ascertain its future potential in the business world. This thesis extends the GDSS research to the area of distributed Group Decision Support Systems (DGDSS). An experiment was performed where groups of three and four persons were tested in different group decision making settings, a traditional decision room and a DGDSS.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

In the past 30 years, information systems have evolved into an essential part of the business environment. Regardless of the nature of the business, private or public, the demand for greater amounts of real-time, accurate, and relevant information is growing. Unlike the past, where having access to this type of information resulted in a significant competitive advantage for a business, rapid flow of information is now a necessity just to maintain a strategic position in today's technologically advanced society.

The proliferation of available information systems with wider varieties of functions and the vast improvements made in these systems are events that have acted to spur the increased demand for information. The old data handling systems such as the typewriter, file cabinet, and many manual recording processes have been replaced in most businesses today by modern information systems, known as Management Information Systems (MIS), that are capable of gathering, manipulating, displaying and storing the same data that had been previously processed by the older systems. Other types of information systems include the Expert System (ES) or Artificial Intelligence (AI). Unlike the MIS, ES/AI's have been developed as specific decision

making information systems. To elaborate further, an ES/AI is developed as an information system which incorporates the knowledge of experts, on a specific subject like trees, gas engines, or electrical circuits, in order to solve problems posed by a user. A person tackling a problem pertaining to the subject the ES/AI is built to answer can submit the question to the ES/AI for a solution.

Between the Management Information Systems, and the Expert Systems ends of the information spectrum is a third information system currently referred to as a Decision Support System (DSS).

Like MIS, DSS characteristics include the ability to gather, manipulate, display, and store data. However, DSS is different from MIS in that DSS is capable of assisting the decision maker in semi-structured problem solving. Keen describes DSS as:

> ...interactive systems frequently used by individuals with little experience in computers and analytic methods. They support, rather than replace, judgement in that they do not automate the decision process nor impose a sequence on the user. [Ref. 1:p. 48]

On the other hand, MIS is only capable of performing highly structured, routine and repetitive functions for which it was programed, like periodic report generation or registering passengers on airlines.

Both DSS and Expert Systems are used for decision making, but a brief contrast of the two will show why Expert Systems can not be considered Decision Support Systems. As

mentioned earlier, DSS is intended to complement, not replace the decision-maker. On the other hand, once sufficient information has been entered into an Expert System, it is designed to make the decision for the decision-maker and in many cases issue appropriate instructions once the decision has been selected. An example would be a medical diagnostic system.

Unlike an Expert System, the DSS does not possess or contain knowledge obtained solely from experts nor is its focus narrow and specific to one interest area such as medical diagnosis. A DSS may be linked to corporate data banks which allow extensive use of a wide variety of data. This allows the DSS to assist the decision maker in a variety of decision problem areas. A DSS also allows the decision maker to project the consequences of potential decisions by the use of "what if" queries.

A DSS may be designed to assist one decision maker (individual DSS), which is currently the most common type of DSS. DSS technology is also being used to support group decision making. These systems are referred to as Group Decision Support System (GDSS), and are defined as follows by Bui and Jarke:

> A group DSS can be defined as a computer-based system that aims at supporting collective problem solving. A collective decision-making process can be viewed as a problem-solving situation in which there are two or more persons (i) each of whom is characterized by his or her own perceptions, attitudes, motivations, and personality, (ii) who recognize the existence of a common problem, and

(iii) who attempt to reach a collective decision. [Ref. 2:p. 9].

Although GDSS is a little known concept to most business environments, it has the potential for making a significant impact on how, when, and where future business decisions will be made. More emphasis is being placed on efficiency in handling information in order to gain a strategic edge and achieve operating efficiency. There will no doubt be great expectations for Information Systems experts to provide the kind of quality products that society has become accustomed to. In addition, the trend in the private sector is towards a growing number of conglomerates relying upon groups of individuals to make decisions about corporate strategy, planning, and crisis resolution.

In this future business environment, group decision-makers many not always find themselves located in the same room, building, or even the same geographical location when the need for a decision develops. Although the cost associated with bringing together geographically dispersed decision makers may be viewed by some private sector businesses as insignificant when they consider the quality of decision obtained, this feeling is not shared by the public sector. With public sector budgets growing tighter each year, even the smallest over-looked opportunity for cost saving can receive wide scale public attention. It is in this geographically dispersed and cost conscious decision

making environment where there is a need for real-time, high quality decisions. The GDSS has the potential to fill this need and thus have a favorable impact on the private and public business sectors.

A. BACKGROUND

Research conducted on Group Decision Support Systems (GDSS) has attempted to identify its future usefulness in the business world. The various perspectives on the different aspects of group decision making: decision quality, decision satisfaction, number of alternatives generated, and decision confidence, have been investigated by such authors as DeSanctis, Gallupe and Dickson [Ref. 3], Turoff and Hiltz [Ref. 4], Van De Ven and Delbecq [Ref. 5], and Tattersall [Ref. 6]. The significance of these aspects cannot be overemphasized when evaluating a GDSS. Some of the reasons are:

- If GDSS use results in better decision quality, as well as measurable assistance to the decision makers, then it can be perceived as a benefit.
- If the GDSS increases users satisfaction with the decision-making environment and process, decision-makers will be more likely to use the GDSS for future group decision making sessions.
- If the GDSS can produce an environment where decision makers feel free to introduce new alternatives and criteria without fear of reprisals from the other group members, there is likely to be more alternatives generated, which will increase the possibility of a better quality decision.
- If GDSS use results in high levels of decision, decision-maker satisfaction and confidence, then satisfaction and confidence will lead to stronger, more

committed and more dedicated implementation of the decision.

In addition to the above mentioned decision making issues, system design characteristics and decision task types--for GDSS decision making--have been investigated by such authors as DeSanctis, Gallupe and Dickson [Ref. 3], Turoff and Hiltz [Ref. 4], Gray, Aronofsky, Kane, Perkins and Helmer [Ref. 7], Huber [Refs. 8, 9], DeSanctis and Gallupe [Ref. 10], and EDP Analyzer [Ref. 11] for purposes of evaluating GDSS potential. Furthermore, research conducted by DeSanctis and Gallupe on the different types of decision making environments have led to four categories of future GDSS usage. They include Decision Rooms, Local Decision Networks, Teleconferencing, and Remote Decision Making [Ref. 10:p. 195].

Past research of all GDSS characteristics: decision making aspects, system design, decision making problem type, and decision making environment, demonstrates that there is a future for GDSS in the business sector. Since there are many different organizations having different needs, and many combinations of user services that can be provided by GDSS, it is necessary to continue the research for finding the best match of user organizations and GDSS. This study will attempt to further the research of GDSS by investigating the development of a Distributed Group

Decision Support System (DGDSS) for use in business organizations with geographically dispersed decision makers.

DGDSS has been referred to by DeSanctis and Gallupe as "remote decision making" and is described as:

> ...uninterrupted communication between remote "decision stations" in a geographically dispersed organization which has a fixed group of people who must regularly make joint decisions....This scenario...removes the constraint of meeting location and addresses the needs of decision makers who must work together on a regular basis. [Ref. 10:p. 197]

The most significant difference between a DGDSS and GDSS is that group members are physically removed from each other and are therefore dependent on a communication facility to interact with each other. Some other characteristics of a DGDSS environment are reduced peer pressure, structured communication, more task oriented communication, less concern with meeting location, and anonymity. The question is whether these characteristics lead to better decision-making and better decisions. Current research and development in the area of distributed group decision support systems is virtually nonexistent, and systems that are being tested are still in the fledgling stages of development.

B. SUMMARY

This paper will extend research in the area of GDSS by evaluating the development and testing of an experimental prototype DGDSS software program developed by ADJ Professor

Ben Mortagy at the Naval Postgraduate School in Monterey, California, in conjunction with Claremont University, Los Angeles, California.

This research will attempt to answer the following questions: Which DGDSS user capabilities are most desirable? Which are most needed? Does the design of the DGDSS enhance or disrupt the decision making process? Does the DGDSS have the potential to provide better decision quality and increased decision maker participation? Can the DGDSS be improved to provide better assistance to decision makers in a distributed setting?

II. LITERATURE REVIEW

Considering that a Distributed Group Decision Support System (DGDSS) is a type of Group Decision Support System (GDSS), an in-depth look into the research conducted to date on both GDSS and DGDSS is appropriate. Furthermore, since a GDSS is very similar, but with some notable differences, to a Decision Support System (DSS) in its components, a brief discussion of DSS will be included at the beginning of this chapter. It will be followed by an expanded definition of GDSS. This GDSS definition will lead into a discussion of GDSS theory involving the following:

- GDSS Configuration.
- DGDSS, A Type of GDSS.
- Design Framework.
- Design Strategy.
- System Capabilities and Levels of Support.
- Task Type/Degree of Difficulty.
- Information Sharing.
- DGDSS Communications.
- DGDSS.

This literature review will conclude with a discussion of previous GDSS empirical studies which relate to the current study.

A. THE DSS

Although there is no agreed upon definition of a DSS, there is consensus among researchers that a DSS does differ measurably in at least two ways from its predecessors. Although a brief DSS definition was furnished in the Introduction, an additional, more involved DSS definition is now appropriate:

> ...a DSS is not merely an evolutionary advancement of EDP and MIS, and it will certainly not replace either. Nor is it merely a type of information system aimed exclusively at top management, where other information systems seem to have failed. A DSS is a class of information system that draws on transaction processing systems and interacts with the other parts of the overall information system to support the decision making activities of managers and other knowledge workers in the organization. [Ref. 12:p. 12]

The first major difference is in a DSS's ability to interact with both the decision maker and other parts of the information system to assist the decision maker in problem solving. The EDP/MIS has the ability to display, retrieve, store, and manipulate data. Capabilities like these are useful if the system is designed to assist the decision maker with problems that are very structured, but are insufficient if the problem is semi-structured or unstructured. Gorry and Scott Morton define structured, unstructured, and semi-structured problems as follows:

> A fully structured problem is one in which all three phases--intelligence, design, and choice--are structured. That is, we can specify algorithms, or decision rules, that will allow us to find the problem, design alternative solutions, and select the best solution....An unstructured problem is one in which none of the three phases is structured..."semi-structured" decisions [have] one or two

of the intelligence, design, and choice phases unstructured. [Ref. 13:p. 63]

An example of a structured problem is calculating the interest rate on a credit account. The original amount, new amount, and elapsed time are known. Embedding this information in an algorithm within the EDP/MIS will produce the interest rate. The only real assistance provided by the EDP/MIS is the calculations. On the other hand, a DSS could assist with this problem as well as problems not having a standard algorithm to use or problems having more than one possible solution, like purchasing the product line for the next year.

The second difference between the DSS and EDP/MIS is in the hardware/software components that exist in the DSS. Sprague [Ref. 12:pp. 12-3] explains that the DSS is composed of three levels of technology: Specific DSS, DSS Generator, and DSS Tools. He goes on to define a Specific DSS as "the system which actually accomplishes the work," the DSS Generator as a package of hardware/software which provides the capability of building a Specific DSS, and the DSS Tools as the hardware/software elements which assist in the development of a Specific DSS or DSS generator. Sprague [Ref. 12:p. 20-5] provides a conceptual model of the DSS's Database subsystem, Model base subsystem, and User System Interface subsystem that displays the technical capabilities a DSS must offer.

In contrast, the EDP/MIS hardware/software components can vary depending on organizational use of the system. If the EDP/MIS is used primarily for data receiving, storing, retrieving, and reporting, it will have a database management system (DBMS) component. It may also have an interactive modeling component which will store a variety of programs that can be used for data analysis. The system will also have some type of dialogue component so that the user can interface with either a DBMS component and/or the interactive modeling component. Unfortunately, unlike a DSS, in an EDP/MIS system the components do not interact independently with each other. For a model to use data from the DBMS component, the data must be first taken out of the DBMS component and then programed into the model by the user.

This brief contrast of EDP/MIS with DSS capabilities and components is needed to present the similarities and differences between DSS and GDSS. Huber defines a GDSS as "a set of software components, hardware components, language components, and procedures that support a subset of the potentially supportable group tasks." [Ref. 8:p. 438] The GDSS is surprisingly similar to a DSS in that it also contains a model base, database, and interface requirement. The difference results from the additional necessary features in the GDSS.

Turban [Ref. 14] lists these features as a communications base, enhanced model base to accommodate group consensus needs, greater up-time, expanded physical features, and increased setup before use of the system. He further claims, however, that when all the added features are removed from the system and the number of members using the GDSS is reduced to one, the GDSS becomes just another DSS. The similarities and differences are nonetheless very distinct, with the main difference being in the type of decision making, individual or group, the system is created to serve.

B. GDSS CONFIGURATION

Since the GDSS is created to assist a group of decision makers, the concept of adapting the GDSS to the decision making environment is very important in the design of the GDSS. In contemporary organizations, a group decision making environment can take the form of members coming together in a conference room with a table and chairs, or by telephone in either a conference call or teleconference situation. A GDSS can mimic both of these configurations and offer two other configurations as well.

DeSanctis and Gallupe [Ref. 10] describe four categories of GDSS configuration: Decision Room, Local Decision Network, Teleconferencing, and Remote Decision Making, which can be designed for organizational group decision making.

1. Decision Room

In the Decision Room, decision makers are seated around a horseshoe-like table with a computer terminal and monitor in front of them. Communication between decision makers can be verbal or by the message capabilities of the GDSS. There is a public display screen to display and highlight member's inputs and group data. A facilitator may be present to operate the system. The advantage of the Decision Room is speed of processing information coupled with the ability to manipulate and display the information to the group members.

2. Local Decision Network

The Local Decision Network provides decision makers with a computer and terminal in their work-space. Group members never have to leave their offices to hold a decision making session. As DeSanctis and Gallupe explain, "A central processor would store common GDSS software and databases, and a local area network would provide member-to-member and member-to-central-processor communication." [Ref. 10:p. 196]. All communication could take place through the GDSS's message system. Displaying of public data and results can be accommodated on the individual computer terminals. The advantage of the Local Decision Network is flexibility in both meeting time and place. This does have a disadvantage of no face-to-face communications which may be very important to some individuals.

3. <u>Teleconferencing</u>

The third category of GDSS configurations is Teleconferencing. Unlike the teleconferencing done by a telephone utility, in GDSS teleconferencing "two or more decision rooms are connected together by visual and/or communication facilities." [Ref. 10:p. 197] This system has the advantage of reducing organizational cost when it comes to travel and increasing flexibility in time and place of meeting.

4. <u>Remote Decision Making</u>

The final category is Remote Decision Making. Although not as well known as the other three categories, Remote Decision Making may have a real future as more organizations become decentralized. With this type of a configuration, decision makers are geographically dispersed in remote areas. Decision making is done in an environmental setting similar to the local decision network with decision makers having their own computer and terminal at their work-stations. Communication between decision makers is accomplished through the GDSS's message system. All public data and results are displayed on individual computer monitors. Remote Decision making is advantageous for reducing travel cost and increasing flexibility in meeting time and place.

C. DGDSS, A TYPE OF GDSS

The Remote Decision Making configuration is the type of GDSS that this research has focused on. A Remote Decision Making GDSS is defined by DeSanctis and Gallupe as "uninterrupted communication between remote 'decision stations' in a geographically dispersed organization which has a fixed group of people who must regularly make joint decisions." [Ref. 10:p. 197]

In this study the Remote Decision Making GDSS will be referred to as a Distributed Group Decision Support System (DGDSS). A subsystem of the GDSS, the DGDSS supports organizational group decision makers who are geographically dispersed but in fixed locations. The DGDSS supports group decision making tasks through asynchronous and/or real-time Wide Area Network (WAN) or Satellite supported computer mediated communication.

Since little research has been done on the DGDSS, previous research on the GDSS that pertains to the DGDSS will be examined next.

D. DESIGN FRAMEWORK

With any GDSS or DGDSS created, the system designer must decide how the system should be created. Criteria considered in designing a GDSS include: group size, member proximity, usage of the system, members' expectations of the system, necessary capabilities and level of support of the

system, category of GDSS, task type and degree of difficulty, and the system delivery mode. By examining these criteria, the designer can create any of the GDSS configurations previously discussed.

Although most of the above mentioned criteria must also be considered when designing a DGDSS, only those which relate to the present study's research questions will be addressed. The following research questions pertain to the design strategy and capabilities and level of support criteria:

- Which DGDSS user capabilities are most desirable?
- Which DGDSS user capabilities are most needed?
- Does the design of the DGDSS enhance or disrupt the decision making process?
- Does the DGDSS have the potential to provide better decision quality and increased decision maker participation?
- Can the DGDSS be improved to provide better assistance to decision makers in a distributed setting?

Since the task type/degree of difficulty criterion has a direct impact on the capabilities of the DGDSS, it will also be addressed. Additionally, because the purpose of the DGDSS is to assist geographically distributed decision makers who may have no immediate recourse if the system fails, two extremely important capabilities, information sharing and communications, will be discussed in depth and separately from capabilities and level of support.

E. DESIGN STRATEGIES

After all of the criteria for the DGDSS/GDSS are examined, a software design strategy can be selected. Various design strategies have been investigated in previous GDSS research. Major strategies include: Technique/Solution Driven, Task Driven, Integrative Approach, and Activity Driven.

1. Technique/Solution Driven

The Technique/Solution Driven strategy supports a specific or a limited number of group tasks. Huber has assessed research institutions and corporations using GDSS's created with a Technique Driven design strategy:

> ...it appears that either the entrepreneuring organizations behind these systems have already segmented the GDSS market...or that individual GDSS designers approached their design task with a decision-aiding technique in mind that followed more from their disciplinary backgrounds than from a careful review of the tasks faced by decision groups. [Refs. 8:pp. 437-8; 9:p. 196]

Huber goes on to point out that the main disadvantage with this strategy is that the GDSS is limited as to the tasks it can support in the organization [Refs. 8,9].

2. Task Driven

A designer using the Task Driven design strategy would examine the users' tasks and then decide on the best kind of system to support these tasks [Refs. 8:p. 440; 9:p. 200]. DeSanctis and Gallupe categorize various tasks by group decision goals [Ref. 15:p. 600]. The category of generating ideas and action would include planning and

creativity tasks. The intellective and preference tasks would fall under the category of choosing alternatives; and the cognitive conflict tasks and mixed-motive tasks would be in the category of negotiating solutions. In addition to the tasks associated with problem solving, Huber describes another possible set of tasks where the "decision group may serve as 'reactors' to descriptions of decisions tentatively made, as information generators, as recommendation generators, or as autonomous decision units." [Refs. 8:p. 440; 9:p. 200]. An advantage to this type of design strategy is that it is not specialized nor specific but open-ended in its capabilities. The disadvantage is that it is not realistic. There are too many combinations of tasks that any given decision making group may actually be involved with.

3. Integrative Approach

The Integrative Approach design strategy stresses the need for considering the behavioral as well as technical issues in designing a GDSS. Developed by Beauclair and Jelassi [Ref. 16], the Integrative Approach addresses certain behavioral issues, such as diffusion of responsibility, deindividuation, pressure toward group consensus, and problems of coordination. These behavioral issues can negatively effect the success of group decision making if not considered during the design phase of the GDSS. If the system designer acknowledges these behavioral issues when

designing the GDSS, he can incorporate into the GDSS appropriate countermeasures to prevent these negative characteristics from impacting group decision making [Ref. 16].

4. Activity Driven

The Activity Driven design strategy focuses on group activities (information retrieval or generation, information sharing, and information use) rather than on group tasks [Refs. 8:p. 440; 9:p. 200]. Suchan, Bui, and Dolk support the use of Activity Driven design strategy and state "GDSS design strategy should focus on general group activities rather than trying to identify and support all possible group tasks. These group activities are identified as information sharing, use, and analysis." [Ref. 17:p. 443] This strategy's advantage is that each possible activity that a decision group could be involved in is considered. Additionally, the technology exists to make this design a feasible option for an organization. The only disadvantage is that it may not be as specific in its capabilities as some users would like.

5. Combining Activity Driven and Integrative Approach

The DGDSS software used in this study is designed using a combination of the Integrative Approach and Activity Driven strategy. This study will further DGDSS research on how the software design strategy enhances or disrupts the decision making process. Similar to the GDSS software

"Decision Aid for Groups (DECAID)" used by Gallupe, DeSanctis, and Dickson [Ref. 3] in their experimental investigation, the DGDSS software used in this research will enable group members to anonymously generate information, store and publicly display criteria and alternatives generated, aggregate and publicly display the groups' ranking's of criteria and alternatives, enable group members to anonymously vote, and correlate the votes leading to the final solution. In contrast to the DECAID GDSS software, the DGDSS software used in this study also provides a message sending/receiving communication component to enable group discussion.

F. CAPABILITIES AND LEVELS OF SUPPORT

GDSS capabilities directly affect the decision makers in the group decision making process. This is because:

- The capabilities provided to the decision maker will depend on the GDSS level of support.
- Certain GDSS capabilities will have an impact on group behavioral issues.
- Capabilities provided will have an effect on GDSS use by the decision makers.

The capabilities provided by a GDSS will most often depend upon the level of support the GDSS is expected to provide the decision making group. Levels of support are defined by DeSanctis and Gallupe as:

> Level 1 GDSSs provide technical features aimed at removing common communication barriers, such as large screens for instantaneous display of ideas, voting solicitation and compilation, anonymous input of ideas and

preferences, and electronic message exchange between members....

Level 2 GDSSs provide decision modeling and group decision techniques aimed at reducing uncertainty and "noise" that occur in the group's decision process.... Modeling tools to support analyses that ordinarily are performed in a qualitative fashion, such as social judgment formation, risk analysis, or multiattribute utility methods can be introduced to the group via a Level 2 GDSS....

Level 3 GDSSs are characterized by machine-induced group communication patterns and can include expert advice in the selecting and arranging of rules to be applied during a meeting. [Ref. 15:p. 594]

The decision as to whether the system should be designed as a Level 1, Level 2, or Level 3 will be determined by the decision makers' tasks (i.e., Planning, Idea Generation, Problem Finding) that the GDSS is expected to support. In turn, most of the capabilities provided by the GDSS will depend on the Level of the GDSS. The editors of EDP Analyzer [Ref. 11:p. 7] believe that "word processing and data processing capabilities, spreadsheet and graphics capabilities, a database management system for handling queries, learning and help facilities, and menus that prompt for the input of text, data, or votes" should be provided in all GDSSs. They go on to list additional capabilities including anonymous recording of ideas and the formal selection of a leader that could be classified as additional GDSS features.

In the current DGDSS study, many of the capabilities proposed by the editors of EDP Analyzer would not be cost

effective or necessary, specifically the word processing, spreadsheets, graphics, and database management system for handling queries [Ref. 11:p. 7]. Furthermore, these capabilities were also missing from the GDSS software used in the experiment conducted by Gallupe, DeSanctis, and Dickson [Ref. 3] with no impact on the final results. This lack of impact may be due to the fact that the GDSS software used in the experiment was a Level 1, and the capabilities provided were dictated by the level of support needed for the decision making task.

While capabilities available in a GDSS can assist a decision making group in the completion of their task, certain capabilities like anonymity, voting, or brainstorming, and their application in any given group decision making session can have a positive impact on group behavioral issues including deindividuation, pressures towards consensus, problems of coordination, and diffusion of responsibility [Refs. 3,4,16,18,19].

Deindividuation occurs when an individual group member becomes so identified with the group that his/her values, morals, and ideas become clouded. The group member gets caught up in the momentum of the group's problem. Jelassi and Beauclair cites examples of lynch mobs and mass hysteria as extremes of this type of behavior. They go on to state that GDSS could help in eliminating this unwanted group behavior because the group member must type in their input

for the decision making session. Using a keyboard, the member must first think of the input, then rethink it when typing it in. This process helps the group member to evaluate his own input prior to submission [Ref. 16].

Pressure towards consensus is very similar to "groupthink". The group member goes along with the group's solution because of his/her identification with the group or because of group pressure to agree. Jelassi and Beauclair point out that groupthink can lead to less alternatives being generated and a very risky group solution. They believe a GDSS can alter this situation by providing anonymity to group members. The GDSS can be designed to allow all phases of group decision making including voting to be anonymous. This reduces peer pressure on members while enhancing their ability to generate input freely [Ref. 16].

Group coordination problems result from a group having no identified leader or lacking structure in their decision making process. Either of these problems could result in the group going off on tangents while trying to find a solution to a problem. Jelassi and Beauclair feel that a GDSS can alleviate this problem by providing structure in group decision making. The GDSS software can be programed to mimic the decision making process and to prompt decision makers for the necessary input at the different phases in the process. With an established structure, the group is

capable of organizing the decision making process which will eliminate the need for a leader and offer a procedure that will lead to problem identification and solution.

Diffusion of responsibility results when some group members feel that the decision, good or bad, is the group's decision but not theirs. When all members of a group feel this way, it may lead the group to choose a less responsible, more risky solution. Jelassi and Beauclair point out that there are situations where diffusion of responsibility can be good in group decision making. An example is when a group is faced with a problem where a creative solution is needed. A GDSS can assist the positive aspects of diffusion of responsibility by allowing for anonymous input of individual information. This anonymity results in members feeling less conservative in their thoughts since no other group member will know who contributed what input. If it is discovered that the group suffers from the negative impacts of diffusion of responsibility, the GDSS can be designed without anonymity of individual inputs, thus placing the member's name next to his input. Finally, the capabilities provided by the GDSS will have a direct impact on the system's use by the decision makers. Huber points out that:

> ...if the system's capabilities are well chosen, the range of tasks supported will increase with increases in the number of capabilities. Thus, there is an eventual synergistic effect on the frequency of GDSS use that follows from the inclusion of capabilities that widen the range of supported tasks. [Ref. 9:p. 197]

All three of the capabilities, voting, anonymity, and brainstorming, presented by Jelassi and Beauclair have been incorporated into the present study's DGDSS software.

The present study will attempt to further GDSS research on which DGDSS capabilities are most needed and desired by decision makers in a geographically distributed decision making environment.

G. USER EXPECTATIONS OF THE GDSS

As previously stated, the success or failure of a GDSS in any organization will depend on its ability to assist a group of decision makers in their problem solving tasks. This determination will be made by the decision makers themselves. They will base their opinion upon not only what the system can do but also on how well the system does it and if the system meets their original expectations.

Since the purpose of a GDSS is to assist in a decision making setting, most decision makers would expect the GDSS to be easy-to-use. When this expectation is not met, decision makers find themselves spending more time trying to learn how to operate the GDSS instead of investigating possible solutions to the problem at hand. This creates frustration with the system that invariably leads to less usage by the decision makers.

Another expectation that many decision makers have is that the GDSS will speed up the decision making process by

retrieving, processing, displaying and calculating information faster then it could be done in a traditional group decision making session. As Jelassi and Beauclair point out, the decision makers' expectations are justified:

> A GDSS should be fast (in terms of response time) for the individual as well as the group. By providing quick results, the GDSS is better able to facilitate the group process. Instant feedback helps reduce confusion on issues, boredom, and enhances confidence in the system. [Ref. 16:p. 151]

The decision makers' expectation that the GDSS should be fast probably resulted from their previous experiences using other computer operated systems. The GDSS should meet this expectation. If the GDSS is designed with procedures that are efficient in their operations, then the GDSS should be reasonably fast. On the other hand, if the GDSS is not designed with efficiency in mind, the decision makers may find themselves waiting for long periods while the GDSS compiles or retrieves data. In a situation such as this, the disgruntled decision makers begin to wonder if the GDSS is even necessary since they may have been able to do the operations faster manually.

Having a defined structure of the decision process improves the degree of accuracy and the response time of the system. Certain software applications such as voting, rating, brainstorming, as well as computerized nominal group techniques can help groups formulate problems clearly

through a predefined structure of the decision process [Ref. 16:p. 150-1].

This structure has proven in many instances (Watson, DeSanctis and Poole [Ref. 20], Steeb and Johnston [Ref. 18], Turoff and Hiltz [Ref. 4]) to be extremely advantageous in assisting the decision making process. Although most GDSS's are developed to provide structure in group decision making, another expectation is flexibility. There is a difference, though, between providing structure and providing flexibility. Flexibility in a GDSS allows the decision makers to error or change their mind without causing complete collapse of the system. Other examples of flexibility would be to allow recall of previously displayed information, switch repeatedly between displays, cancel a message prior to transmitting, and make a mistake that doesn't result in being dumped from the system. Failure to provide flexibility in a GDSS can result in decision makers choosing not to use the system because they are unable to work within the limitations set forth by the system.

Finally, some users have unrealistic expectations of what a GDSS can do. These expectations range from expecting the GDSS to handle every task imaginable to believing the GDSS will provide the decision makers with a perfect solution. As ridiculous as these expectations may sound, a vague explanation of GDSS's and their capabilities offered by developers and vendors may unintentionally lead group

members to believe that such an advanced system exists. The following excerpt taken from an actual study conducted by Watson, DeSanctis and Poole, demonstrates that this belief in the existence of such advanced GDSS systems should not be disregarded as imaginary. "Group members [expect] the computer to produce the solution for them. They [focus] on using the system very mechanically and [are] sometimes dismayed when the system [does] not magically give the 'right' answer." [Ref. 20:p. 475]

The developer or vendor of the GDSS should ensure that decision makers understand the system's capabilities. This will promote system usage and reduce user frustration.

H. TASK TYPE/DEGREE OF DIFFICULTY

Decision makers rarely are faced with making decisions on one type of task throughout their entire work-life. Most organizations address a multitude of problem types in the daily operation of their business. Because of this task variety faced by organizations and the decision makers who run them, the subject of task type and its characteristics must be examined when designing a GDSS. DeSanctis and Gallupe [Ref. 15] introduce six task types that decision makers may face when working in a group decision making session: Planning, Creativity, Intellective, Preference,

Cognitive conflict, and Mixed motive. Each of these tasks can be broken down into one of three categories--Generating, Choosing, and Negotiating--which delineate the purpose of the group decision making session. DeSanctis and Gallupe briefly define these categories as follows:

- GENERATING ideas and actions. Planning tasks require generation of action-oriented plans. Creativity tasks require generation of novel ideas.

- CHOOSING alternatives. Intellective tasks require selection of the correct alternative. Preference tasks require selection of an alternative for which there is no objective criterion of correctness.

- NEGOTIATING solutions. Cognitive conflict tasks involve resolution of conflicting viewpoints, and mixed-motive tasks involve resolution of conflicting motives of interest. [Ref. 15:p. 600]

The importance of considering the tasks confronting the group when designing the GDSS cannot be overemphasized. By evaluating the tasks, the designer can identify the GDSS capabilities needed to assist the decision makers.

An important characteristic of a task is the level of difficulty associated with it. DeSanctis, Gallupe, and Dickson [Ref. 3] explain task difficulty as being a relative concept that can only be measured by comparing it to other tasks.

> Assessment of task difficulty can be made by asking decision makers their perceptions of relative difficulty. But evidence of difficulty is more objectively implied in (1) decision makers' relative performance in tasks (more difficult tasks will be properly completed by a smaller proportion of people than less difficult tasks), and (2) the amount of time spent in completing the task (more difficult tasks will take longer for people to complete than less difficult tasks). [Ref. 3:p. 280]

Tasks requiring extensive use of mathematics or presenting extreme risk to the organization may be viewed as being very difficult to some, yet fairly easy to others. It will eventually depend on the decision makers as to the perceived level of difficulty of any particular task. But the possibility of extreme difficulty in a task, implied or factual, should be taken into consideration when designing the GDSS.

Another characteristic of the decision maker's task that must be considered is its ability to invoke a sense of "emotion" in the group. Emotion in group members can best be understood by considering how group members will approach certain decision making sessions. If the session is called to solve an organization's operating problem which is important but neither life threatening nor financially catastrophic, group members will probably go about the decision making session in a calm, resourceful manner. On the other hand, if the session is called to find a solution to a crisis situation or sensitive problem, the decision makers may feel a greater sense of urgency and purpose in finding a solution. Designers of the GDSS should note that the patience demonstrated by decision makers working on one type of problem may not be the same when faced with a more emotionally demanding problem. Problems in the operation of the GDSS, information processing speed, or GDSS capabilities

provided will not be tolerated quietly by decision makers trying to work out a crisis.

There is still another view presented by Suchan, Bui, and Dolk in a Contingency Model of the GDSS assisting decision makers with tasks. The model correlates tasks to relationship bringing about areas where a GDSS may not assist the group decision makers well at all. They define task and relationship as follows:

- Task: a problem whose solution requires precise, linear thinking.
- Relationship: a relatively unstructured problem whose solution affects the formal and informal values and norms of behavior (in the broadest sense) held by corporate staff and the organization's employees. [Ref. 17:pp. 444-5]

Using the Contingency model to show relative effectiveness of the GDSS, Suchan, Bui, and Dolk demonstrate that in High Relationship/Low Task and Low Relationship/Low Task problem types faced by decision makers, the decision makers would not benefit from the use of a GDSS. With High Relationship/High Task problem types, the decision maker could benefit from a GDSS, but the GDSS should be integrated with some other form of problem solving. Finally, the Low Relationship/High Task problem type is strongly recommended for the GDSS environment. Although extensive research to support the claim of the contingency model has not been done, the concept is worth examing especially since the

aspect of relationship in problem solving is not an analytical but an emotional factor. Considering that a GDSS is designed for rational problem solving through usage of data, input, and model applications, there is nothing built into the system to support emotional factors that may be important in some organizational decision making sessions.

The current DGDSS study incorporates a crisis planning type task with a high degree of difficulty. It would be rated as High Relationship/Low Task in the Contingency model. By using this task type and degree of difficulty, this study should further the research on the potential of a DGDSS assisting decision makers handling this type of problem solving situation.

I. INFORMATION SHARING

Information sharing is the one capability that must be taken seriously when designing a GDSS.

> Groups are superior to individuals for decision analyses. Groups are usually better at generating options and probing their relative advantages and disadvantages; therefore, groups have a better chance of structuring an ill-structured situation. However, to be effective a group will require a great deal of communication among the participants. [Ref. 4:p. 82]

Without the ability to share information, the idea of group decision making is reduced to individual decision maker's recommending personally contrived solutions based on limited information.

Since the group decision making process does require the members to interrelate with each other to reach a solution, the GDSS provides a medium to support group interaction called the information sharing capability. The GDSS information sharing capability will enable the group to display, transmit, and receive information. Additionally, as demonstrated by Huber [Refs. 8,9], the information supported can be textual, numeric, or relational depending upon the design of the information sharing capability.

In addition to providing group decision makers with a medium to share information, the GDSS information sharing capability purposely changes the mode of group decision making communications. As explained by DeSanctis and Gallupe:

> Supporting group decision making primarily involves changing, in a positive direction, the interpersonal exchange that occurs as a group proceeds through the problem solving process. In this sense the goal of GDSS is to alter the communication process within the groups. The greater the degree of change in communication introduced by the technology, the more dramatic the impact on the decision process and, presumably, on the decision outcomes. [Ref. 15:p. 591]

As DeSanctis and Gallupe point out, the GDSS information sharing capability is dynamic, with the design differing from one GDSS to another. The information sharing capability can be limited to receiving and displaying group members information on a public screen or it can be expanded to include private display, manipulation of information, and other features. Because there is no one specific

information sharing design that is suitable for all GDSS's, it is imperative that the designers of the GDSS investigate how the system is expected to enhance the group decision making process.

In their presentation of different behavioral issues that can affect the group decision making process, Jelassi and Beauclair explain how the GDSS's communication and information sharing capability can be designed to enhance group decision making.

> The system should provide communication and information sharing as much as possible and when desirable. This should be accomplished through local as well as public display, and allow for brainstorming in addition to data and model sharing. This feature would allow participants to generate ideas freely and without prejudice, and have a shared model that can serve as a basis for discussion. [Ref. 16:pp. 151-2]

The ability of the GDSS to support information sharing among group decision makers is extremely important. This importance is magnified when the information sharing capability being designed is part of a DGDSS.

When the group decision makers are geographically distributed, they are unable to both see and verbally communicate with each other. Their only means of communication and information exchange is provided by the DGDSS. Since they are jointly working on a problem, it is of the utmost importance that they know the group's progress towards finding a solution and be able to communicate with other members on that progress. The DGDSS assists by

receiving and displaying on each decision maker's computer terminal all information about the problem as the problem is worked on. Additionally, since it is natural for decision makers to discuss information, the DGDSS has a communication component that enables decision makers to send and receive messages.

Although the DGDSS illustrated presents a very limited information sharing and communication capability, it demonstrates that without these capabilities the DGDSS cannot assist group members in the distributed decision making process. The information sharing capability and communications component are the two most vital parts of the DGDSS. Furthermore, it should be evident that even if the group members are not geographically distributed, and they are using a GDSS instead of a DGDSS, without an information sharing capability, the system cannot assist the group in the decision making process.

J. DGDSS COMMUNICATIONS

For a DGDSS to provide the kind of support needed to adequately assist the group decision makers in a real-time distributed decision making meeting, the communication component would have to be enhanced beyond the capabilities offered in a regular GDSS. Bui and Jarke [Ref. 2] identify and explain three roles, Coordinator, Detective, and

Inventor which they view the communication's component of the DGDSS as having to play throughout a decision session.

The coordinator ensures that a specific communications protocol is kept throughout the decision session. This protocol will ensure that there is equal opportunity for participation and no one individual can manipulate the communications process. The Detective ensures that personal data, information, or voting remains anonymous. The Inventor takes note of incorrect formats in exchanging information and suggest other possible formats.

Bui and Jarke [Ref. 2] propose an architecture which would link the communications component with the individual computer terminals throughout the DGDSS with the use of a computer network:

> The communications component could be built by implementing a Group Norm Constructor, a Group Norm Filter, an Invocation Mechanism, and a circumstance-shaped IDSS-to-GDSS Formatter in the application and presentation layers of the ISO model. [Ref. 2:p. 18]

Although an actual application of this architecture has yet to take place, the concept proposed does have possibilities as a future method of DGDSS communications.

K. DGDSS

Although DGDSS and GDSS design may differ slightly, a proper design that provides the needed capabilities--especially information sharing--is for equally important for both. However, the DGDSS communication component will hold

greater importance than it would in a regular GDSS. The ability for decision makers to communicate quickly and without difficulty is imperative for a DGDSS to be effective.

Finally, the DGDSS must have the confidence of the group decision makers. Although this is true of any GDSS, it is especially relevant in the case of the DGDSS. When individuals are remotely located and their DGDSS computer terminal begins to malfunction due either to technical error or operator error, the frustration felt by the decision maker would be magnified dramatically compared to a similar problem in a Decision Room setting.

There is a future for the DGDSS, but more research on development and design as well as actual experiments of a system will be needed before the extent of its potential is known.

L. PREVIOUS EMPIRICAL STUDIES

The current study hopes to further GDSS research by evaluating and testing an experimental prototype DGDSS software program. Through this investigation, the following research questions will attempt to be answered:

- Which DGDSS user capabilities are most desirable?
- Which DGDSS user capabilities are most needed?
- Does the design of the DGDSS enhance or disrupt the decision process?

- Does the DGDSS have the potential to provide better decision quality and increased decision maker participation?

- Can the DGDSS be improved to provide better assistance to decision makers in a distributed setting?

Although no previous empirical studies exist on the DGDSS, studies by Gallupe, DeSanctis and Dickson [Ref. 3], Turoff and Hiltz [Ref. 4], Steeb and Johnston [Ref. 18], Nunamaker, Applegate and Konsynski [Ref. 19], and Watson, DeSanctis and Poole have been conducted on the GDSS [Ref. 20]. Through these previous studies, knowledge has been obtained on various effects that a GDSS has on the group decision process. Since the DGDSS is a subsystem of the GDSS, previous research results in the areas of interest that relate to the questions posed in the current study will be discussed. However, because each previous research study is unique in its composition, a brief summation of each study and its results that relate to the current study will be presented first.

1. Gallupe, DeSanctis, and Dickson

Gallupe, DeSanctis, and Dickson's [Ref. 3] study used a problem finding task type. They investigated the effects that the level of task difficulty would have on different aspects of the group decision process, including decision quality, number of alternatives generated, and satisfaction with decision process. The results of their study demonstrated that use of the GDSS both improved

decision quality and increased the number of alternatives generated by decision makers, regardless of the degree of task difficulty. Additionally, they found that the degree of task difficulty between the GDSS groups did not affect the decision makers' satisfaction with the decision process. However, the GDSS groups were significantly less satisfied with the decision process then the non-GDSS groups.

2. Watson, DeSanctis, and Poole

Watson, DeSanctis, and Poole's [Ref. 20] study compared the effects of group consensus among three groups: those assisted by a GDSS, those assisted with paper and pencil but no GDSS, those with neither a GDSS or paper and pencil. The task type used was a preference allocation problem. Among the various results of their study, it was demonstrated that GDSS groups had generated more input into the group's solution then either of the non-GDSS groups. Additionally, they found that the structure provided by the GDSS assisted in managing group conflict which improved the degree of post meeting consensus.

3. Turoff and Hiltz

The Turoff and Hiltz [Ref. 4] study incorporated a computerized conferencing system to serve as a GDSS. Their experiment was two-fold. First they compared groups using the system for an unstructured decision process with groups meeting in a traditional face-to-face decision session. They then did a second experiment using the same format for

the non-computerized group; but, in the computerized group, they assigned a group leader and incorporated statistical capabilities into the system that would display group progress. The problem used was an intellective task type with a moderate to high degree of difficulty. Their experiment focused on decision quality and consensus on final solution. The results of the first experiment demonstrated that the quality of decision did not differ between the two groups regardless of the computerized conferencing system. However, decision quality for the computerized groups did improve in the second experiment.

4. <u>Nunamaker, Applegate, and Konsynski</u>

Nunamaker, Applegate, and Konsynski's [Ref. 19] study investigated the influence of automated technology on the idea generation and analysis phases of decision making when using a planning task type. Their experiment was conducted on participants using electronic brainstorming software. The results of the study indicated a high degree of satisfaction among the participants with the electronic brainstorming system for idea generation. Additionally, participants demonstrated a high degree of satisfaction with the outcome of the session as well as the process used to achieve the goals of the session.

5. <u>Steeb and Johnston</u>

Steeb and Johnston's [Ref. 18] study incorporated a crisis planning task type with a high degree of difficulty.

They found that groups using the GDSS were more satisfied with the number of alternatives generated and the opportunity to look back at the group's progress, but group members were more resistant to decision making procedures. Furthermore, some members in groups with no GDSS support felt that viable alternatives were dropped due to group pressure, and more structure in the deliberation phase of the decision process was needed.

6. Correlation Between Previous Research and Current Study

The current study is similar to the Steeb and Johnston study in that a crisis planning task type problem with a high degree of difficulty is used. Unlike Steeb and Johnston, though, the level of support provided by the DGDSS is only a level 1, whereas theirs was a level 2. The reason behind the difference is that although many facets of the problem faced are very similar--including that of a terrorist situation--level 2 capabilities were not provided in the experimental DGDSS prototype. The lack of this capability is not expected to affect the outcome of the study because it is believed that crisis planning can be done adequately without level 2 support.

Similar to Gallupe, DeSanctis, and Dickson [Ref. 3], and Turoff and Hiltz [Ref. 4], the current study is interested in decision quality. Although the Gallupe, DeSanctis, and Dickson study results showed the degree of

task difficulty had no significance on decision quality, it did demonstrate that use of a GDSS resulted in greater decision quality. Since the only differences between the current study and the one by Gallupe, DeSanctis, and Dickson, are the task type and configuration of the GDSS, it is expected that any difference between the results of the two studies would be due to these two variables. However, as mentioned previously, the Steeb and Johnston study also used the same task type with no noted decrease in decision quality. Therefore, if decision quality is found to be negatively affected in the current study, it may be due to the DGDSS itself or the decision setting. Furthermore, Turoff and Hiltz stated that decision quality improved with the incorporation of a defined leader and "computer feedback" capabilities. The current study provides structure to the decision session as well as information sharing capabilities to display information generated through the experimental prototype DGDSS software. If the current study's results demonstrate poor decision quality and evidence that the DGDSS is disrupting the decision making process, then the design structure and capabilities may be the cause of these results.

The current study will also measure whether there is an increase in decision maker participation. Studies by Gallupe, DeSanctis and Dickson, Steeb and Johnston, Nunamaker, Applegate and Konsynski, and Watson, DeSanctis

and Poole demonstrated high satisfaction among decision makers on the number of alternatives generated [Refs. 3,18, 19,20]. Since alternatives generated directly relates to decision maker participation, the high group member satisfaction level resulting from the number of alternatives generated was due to greater participation by decision makers. If this inference is true, then the present study should have results demonstrating increased DGDSS decision maker participation.

Finally, previous research on satisfaction with the decision process differs among studies. Gallupe, DeSanctis, and Dickson [Ref. 3] reported that decision makers were less satisfied, while Nunamaker, Applegate, and Konsynski [Ref. 19], and Steeb and Johnston [Ref. 18] found decision makers to be highly satisfied. What caused these differences is unknown. It has been speculated that it may be due to the difference between the levels of GDSS support. However, it is unlikely that the level of support played a great role since only Steeb and Johnston used a level 2 GDSS and the other two studies used level 1 GDSS's. As previously mentioned, the current study also uses a level 1 GDSS and will attempt to find out if the DGDSS enhances or disrupts the decision process. This study's final results on DGDSS's effects on users' satisfaction with the decision process will clarify reasons for these contradictory research results.

Although previous GDSS empirical studies are limited, they have resulted in furthering the research in the field of group decision support systems. Additionally, they have laid the ground-work for further GDSS studies to be conducted that will result in concurrence or divergence with the results of the previous studies, or possibly even an investigation into a different area of GDSS research that has yet to be encountered. It is this different area of GDSS research, the DGDSS, that the current study will investigate in an attempt to further GDSS research.

M. SUMMARY

A brief explanation of DSS and its similarities and differences to GDSS opened this chapter. This was immediately followed by an in-depth look at major aspects of the GDSS including: Categories of GDSS, Design Frameworks and Strategies, System Capabilities and Levels of Support, Task Types and Degrees of Difficulty, and Information Sharing, and the relevance of each respective aspect to DGDSS and the current study. Also included was a discussion on the importance of the communications component in the DGDSS. Since the central focus of the current study is the DGDSS, a brief explanation of the importance of proper design and user confidence was presented. This literature survey was concluded with a discussion on previous GDSS empirical studies that demonstrated results to research

questions on the GDSS which are similar to the questions purposed in the current DGDSS study. By using the knowledge offered by the previous studies as a guide, it is expected that the results of this study will extend GDSS research in the area of DGDSS.

III. RESEARCH METHOD

A. SUBJECTS

This study was based on an experiment involving six four-person and four three-person groups. Three and four-person groups were used, as has been done in previous similar studies, (Turoff and Hiltz, 1982 [Ref. 4]; Steeb and Johnston, 1981 [Ref. 18]; Watson,DeSanctis and Poole [Ref. 20). Of the 36 subjects, four were female. Subjects were selected from officer-student volunteers of the Computer Systems Management curriculum at the Naval Postgraduate School (NPS), Monterey, CA.

Graduate students are attractive subjects for experiments such as this because of their similar age, experience and background. NPS students of the CSM curriculum offered additional qualities in that they share relatively common military backgrounds, have established working relationships as small groups, and a higher level of experience with computer equipment than students of other curriculums. Subjects were either in the process or had completed one course in Decision Support Systems and therefore were familiar with DGDSS terminology.

1. Group Composition

Of the 36 subjects who participated in the study, 22 subjects participated in the DGDSS experiment--four

four-person groups and two three-person groups. Fourteen subjects participated in the traditional decision sessions--two four-person groups and two three-person groups.

B. THE DGDSS

The DGDSS software used in this experiment was adapted from a prototype version of a GDSS currently under development at Claremont University in Los Angeles, CA. The version used in this study was modified for use in distributed settings (DGDSS). The software was designed to generate criteria and alternatives and to help generate consensus through anonymous ranking of alternatives.

The system provides a means for recording and displaying problem, criteria, and alternative descriptions. It also allows the decision makers to add their own comments to criteria and alternatives. Since the system is distributed, a browsing feature is included for decision makers to review each others' inputs. Once the ranking, weighing and scoring of criteria and alternatives are entered, the results can be displayed. An electronic mail facility is included for sending short messages between decision makers.

The DGDSS provides a systematic, structured process for decision making in that each decision maker reviews the problem description, enters and ranks criteria, enters and ranks alternatives, assigns relative weights to criteria,

scores alternatives against criteria, and displays the results.

The system uses a menu driven format where each menu contains a set of cards. Each card equates to a module which controls a phase--criteria, alternatives, scoring--in the structured decision process. Cards are easily selected by using the arrows on the terminal keyboard and when selected lead to submenus with additional sets of cards. Figure 3.1 shows the main module menu for the system.

C. PHYSICAL SETTING

1. DGDSS

The DGDSS software was installed on an IBM PC Local Area Network (IBM PC LAN, version 1.10) laboratory at NPS that was designed for research such as this study. Five terminals were designated for the DGDSS, four used by the decision group and one for the facilitator. One terminal was left out of the system when testing groups of three. Each terminal consisted of an IBM PC (AT) compatible with color monitor, keyboard, dual floppy disk drives, and hard disk drive. The DGDSS terminals were isolated from each other by using portable room partitioning devices to create individual booths, thus giving the effect of a distributed environment. The rear of each booth was left open to allow facilitators to observe and assist subjects

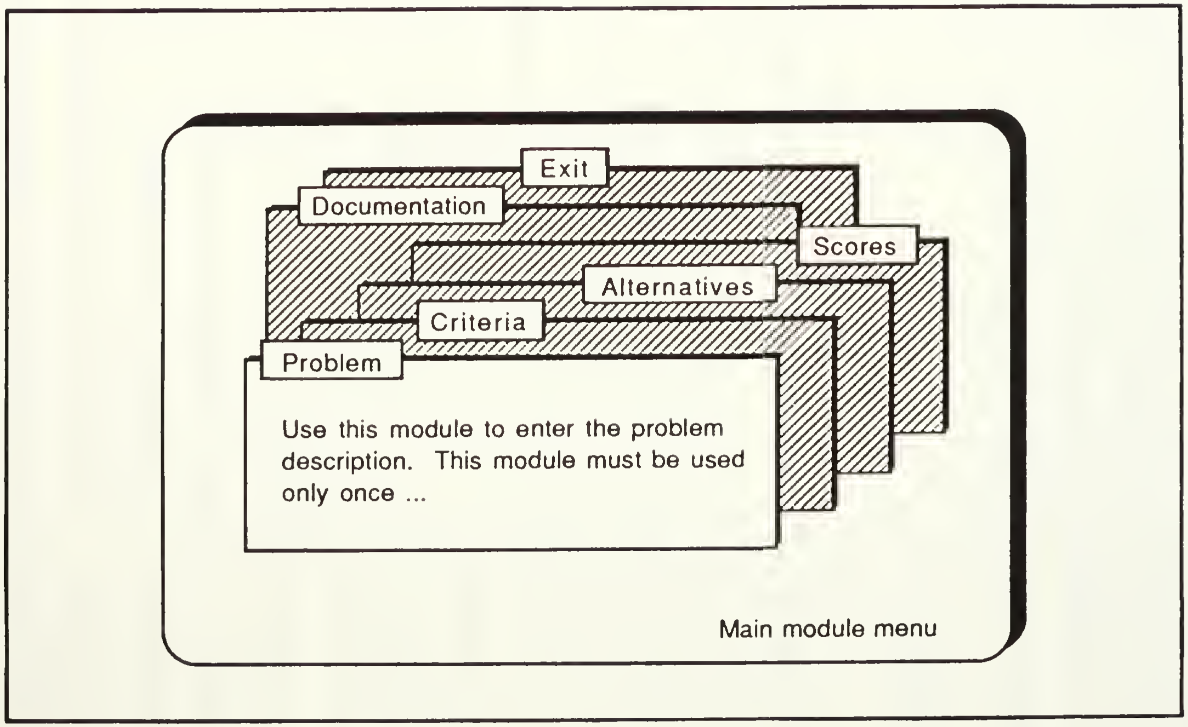

Figure 3.1 Main Module Menu

(see Figure 3.2). DGDSS subjects were provided with a user's manual for operating the DGDSS program.

2. Traditional

The traditional setting was a conference room with a large conference table. The conference room was reserved in advance to ensure no interruptions. Subjects were provided writing utensils, paper, and a form to record the group's criteria, alternatives and final solution.

3. Facilitators

Previous research describes the function of facilitator as the operator of the technology that supports the group activity. The facilitator is responsible for conducting the group meeting and directing the participants through the group process technique [Ref. 21:p. 356-7]. With respect to DGDSS Kraemer and King describe the role of facilitator as:

> The facilitator's role usually evolves to that of a trainer and troubleshooter, teaching the participants how to use both the hardware/software and the group process...and then remaining available for help as problems arise.... [Ref. 21:p. 356-7]

Facilitators were provided in this study for traditional and DGDSS sessions. Facilitators' functions were to schedule sessions, reserve decision rooms and provide writing materials. DGDSS facilitators installed software, provided instruction on use of software, gave advice to decision makers about the decision process, controlled the decision process, manipulated data, performed

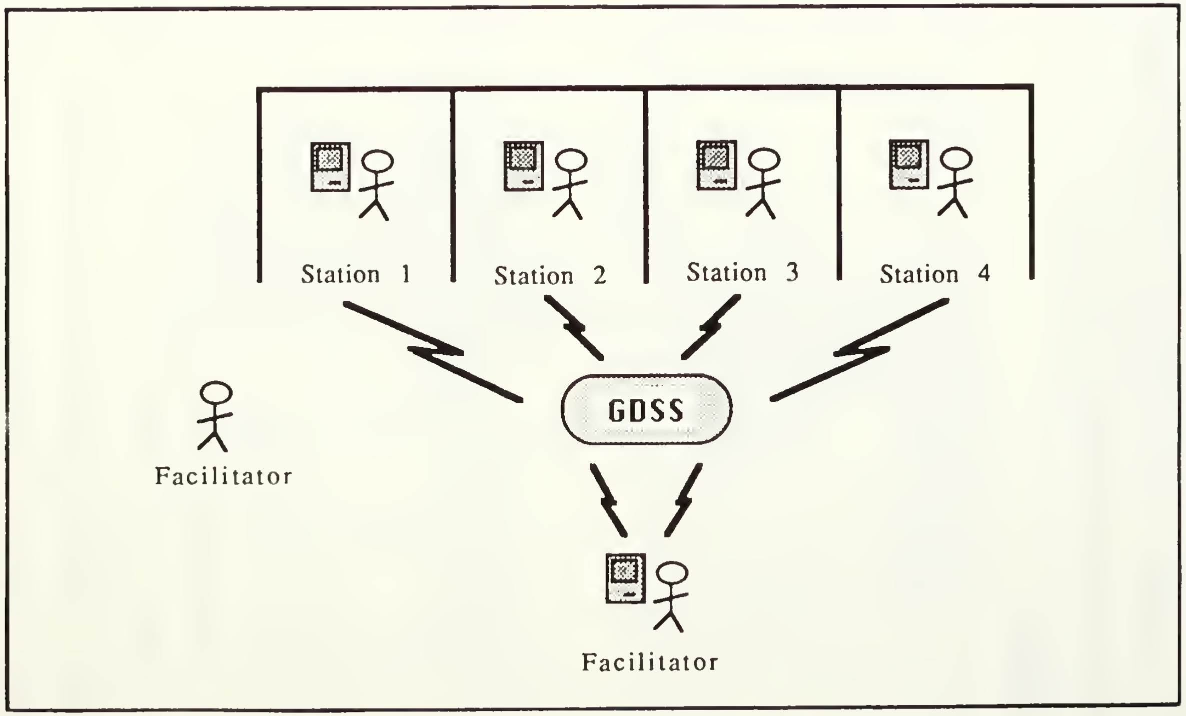

Figure 3.2 Physical Design

calculations, controlled displays, and gave technical assistance. In addition, DGDSS facilitators were responsible for: (1) ensuring that communication remained characteristic of a distributed environment; (2) resolving problems that might impede or jeopardize the experiment; (3) and observing, monitoring and recording data relevant to the experiment.

D. SOFTWARE

DGDSS software consisted of two programs, one for decision makers and the other for the facilitator. The decision makers' program was made up of four main modules: problem, criteria, alternatives, and scores.

Each module provided services for a different phase of the decision process. The problem module allowed the decision maker to log-onto the decision session. The criteria and alternatives modules provided a means for entering the descriptions, ranking, and displaying results. The scores module was used to assign relative weights to criteria, score alternatives against criteria, and display the final solution. The facilitator program allowed the facilitator to enter the problem description and control the decision process. The facilitator could also combine redundant criteria and alternatives and impose cut-off values for ranking. Cut-off values were used to discriminate against low ranking criteria and alternatives.

By eliminating those that fell below the cut-off value, only higher ranking, more desirable criteria and alternatives are retained for subsequent re-ranking. In addition, the software provided a message sending facility for the facilitator and decision makers.

1. Theory of Operation

The DGDSS software uses a variation of Saaty's "Analytic Hierarchy Process" (AHP) to generate consensus. AHP is a framework for decision making that adds structure to unstructured problems by dividing the problem into its different components. The process organizes feelings and intuition and logic in a structured approach to decision making and aids group decision making by adding discipline to the group thought process [Ref. 22:p. 3-26]. The following is a brief summary of AHP:

> The analytic hierarchy process enables decision makers to represent the simultaneous interaction of many factors in complex, unstructured situations. It helps them to identify and set priorities on the basis of their objectives and their knowledge and experience of each problem. [Ref. 22:p. 12-3]
>
> Each set of elements in a functional hierarchy occupies a level of the hierarchy. The top level, called the focus, consists of only one element: the overall objective. Subsequent levels may each have several elements....[T]he elements in one level are...compared with one another against a criterion in the next higher level.... [Ref. 22:p. 28]

The DGDSS software in this study used a hierarchy of three levels: final solution, criteria, and alternatives. The criteria and alternative levels had multiple elements.

Criteria were given a priority by assigning each a relative weight. Alternatives were then compared--scored--with each other against each criterion to arrive at a final solution. (See Figure 3.3)

E. SESSION

DGDSS and traditional sessions were scheduled for two-hour periods. Sessions were allowed to continue past two hours if necessary. Sessions were divided into three parts: a brief description of the session, the actual decision problem session, and a questionnaire evaluation. Additionally, the DGDSS session included a 30 minute training session. At least one day prior to each session, subjects were given a one page pre-scenario. The pre-scenario provided pertinent background information about the decision problem but did not divulge the specifics about it. A copy of the pre-scenario is included in Appendix B.

1. DGDSS

Subjects were provided with an abbreviated users manual to use as a memory-aid during the session; however, the guided session was usually sufficient to preclude the need for the user's manual. Facilitators described the definitions of criteria and alternatives and gave an explanation of ranking, weighing and scoring. Subjects were allowed to communicate freely during the practice session.

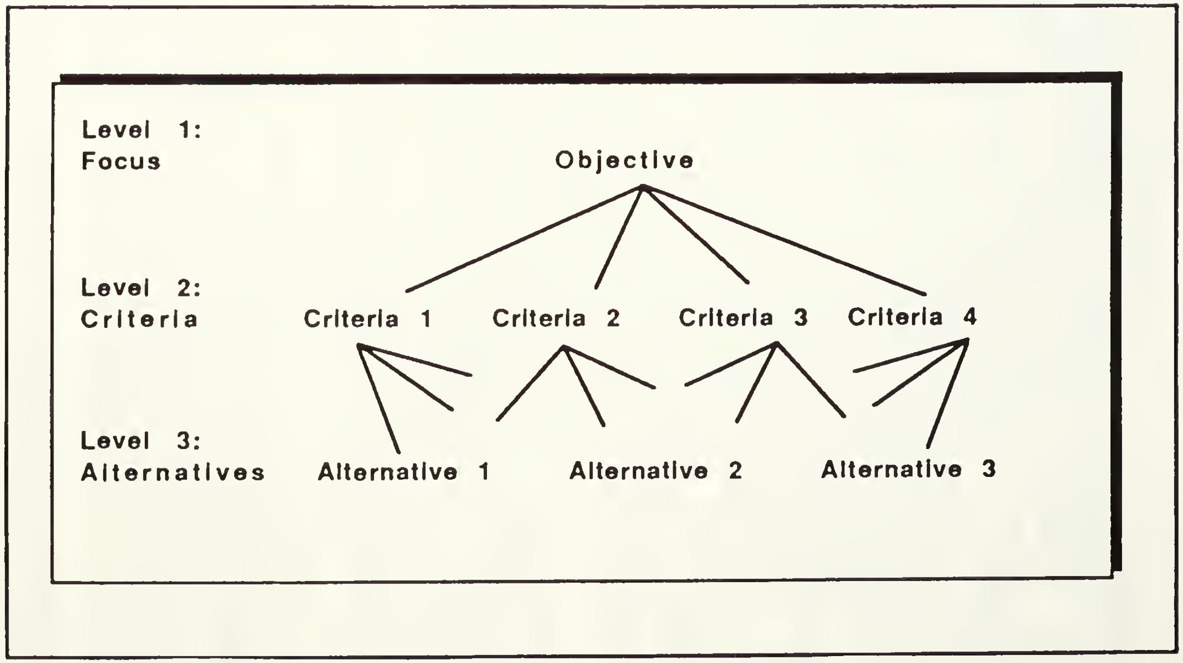

Figure 3.3 Analytical Hierarchy

Following the practice session and short break, subjects were presented with the decision problem scenario. Upon receiving the scenario, subjects were not allowed to ask questions relating to the scenario but could request assistance concerning technical matters such as program operation. Subjects were asked not to discuss the scenarios or session with other subjects during the session. Subjects were allowed to communicate only by using the DGDSS program, which allowed each to enter inputs into the system and to review the inputs of other decision makers by using the message sending facility. The facilitator ensured that sessions adhered to the following agenda:

- Criteria generation.
- Criteria ranking and review.
- Alternative generation.
- Alternative ranking and review.
- Criteria weighing.
- Alternative scoring.

a. Criteria Generation

At the beginning of the decision session the facilitator started and set-up the DGDSS program in the criteria phase of the decision process. The decision makers could only access the criteria module of their program at their terminals. When ready, subjects began entering criteria and their descriptions into the system. When subjects were satisfied with criteria entered, or wanted to

see criteria entered by others, they could browse the criteria. This allowed them to view all criteria entered at the time. Subjects could add their own comments to criteria entered by others, which could then be reviewed by the group. If redundant or duplicate criteria were entered, the facilitator would combine the criteria upon request from the decision group. Subjects would inform each other when they completed their criteria entries and were ready to rank them.

b. Criteria Ranking and Review

The anonymous ranking of criteria used a five point scale to express their desirability--five being most desirable and one being least desirable. Criteria ranking addressed the desirability of each criterion individually, based on its own merit alone. That is, ranking was not intended to compare a criterion with any other criterion. This provided a way to eliminate undesirable criteria from subsequent phases of the decision process by retaining the most desirable criteria. The subjects signaled the facilitator when rankings had been released (sent) to the facilitator. When all subjects had signaled, the facilitator calculated the results of the ranking and sent results back to decision terminals for display and review by the subjects. The subjects could choose to accept--unanimous consent from the decision group--or reject the ranking. If the ranking was accepted, the facilitator set the program

to the alternatives phase and signalled the subjects to begin the next phase of the decision process. If rejected, the ranking was repeated until accepted.

c. Alternatives Generation

When the facilitator had set up the program in the alternatives phase, subjects were confined to the alternatives module of their program. Subjects began entering, browsing, and adding comments in the same manner as they had done with criteria. Redundant and duplicate alternatives were combined by the facilitator upon request from the decision group. The subjects informed each other when they completed their alternatives entries and were ready to rank.

d. Alternatives Ranking and Review

Anonymous ranking of alternatives also used a five point scale to express desirability of alternatives--five being most desirable and one being least desirable. As with criteria, alternative ranking addressed the desirability of alternatives individually, based on merit alone and not compared to other alternatives. The subjects signaled when rankings had been released (sent) to the facilitator. The facilitator calculated the results of ranking and sent results to decision terminals for display and review. Subjects could choose to accept or reject the ranking in the same way they had done for criteria. If the ranking was

accepted, the facilitator signaled to begin the next phase of the decision process.

e. Criteria Weighing/Alternative Scoring

When the facilitator set the program in the scoring phase, subjects were confined to the scoring phase. The scoring phase was made up of two procedures, weighing of criteria and scoring of alternatives against criteria.

Where criteria ranking considers each criterion alone, criteria weighing compares criterion with other criteria. Weighing used a five point scale which expressed the relative importance of one criterion in relation to others--five being high and one being low. For example, two criteria might be given weights of two and one. This says that the criterion given a weight of two is twice as important as that which was given a weight of one. When the subjects entered weights for each criterion, they continued with the next procedure, alternative scoring.

Alternatives were given a score between one and 100. Scores provided a means of expressing how well subjects felt each alternative addressed or satisfied each criterion--one being worst, 100 being best. Each alternative was scored against all criteria. This meant that if five criterion were entered, each alternative would receive five scores--one for each criterion. In addition, if five alternatives were entered, there would be a total of

25 scores entered--five alternatives each receiving five scores.

Subjects signaled the facilitator when the scores had been released (sent) to the facilitator. The facilitator calculated the final score and sent results to the decision terminals for display and review by the decision makers. Results of scoring was presented in the form of a bar-graph with alternatives arranged in the order of their final score. The highest scoring alternative was the groups' solution to the problem. The group could choose to accept--unanimous consent by the group--or reject the solution. If rejected, the scoring phase was repeated until a solution was accepted. If accepted, the solution was recorded as the final solution and the decision session was concluded. The subjects were then presented with questionnaires for evaluating the DGDSS session.

2. Traditional

Subjects met in the conference room with the facilitator. The facilitator defined criteria and alternatives for the subjects. Subjects were provided with writing utensils, paper, and a form to record criteria, alternatives and its final solution. When subjects were ready to begin, the facilitator presented the problem scenario. Subjects were allowed to communicate freely throughout the session and informed they could use any method they found convenient to solve the problem. A

facilitator remained present during the session to collect data and observe the decision process but did not interfere in any way with the session. When subjects had reached a final solution, the facilitator collected the list--criteria, alternatives and final solution--and presented subjects with the questionnaire. Upon completion of the questionnaire, the session was concluded.

F. QUESTIONNAIRE

Questionnaires were adapted from those used in similar research done by Hughes and Webb, and Watson [Refs. 23,24]. DGDSS questionnaires contained 35 questions of which 31 solicited responses on seven-point scales and four requested short comments. Traditional group questionnaires contained 27 questions, 26 seven-point and one short comment. In addition, both DGDSS and traditional questionnaires included eight questions about the subjects' personal and background information. Copies of each questionnaire are included in Appendix A.

1. DGDSS

The DGDSS questionnaire was designed to gain information about the following:

- Case problem validity.
- Suitability of the case problem for DGDSS.
- Decision satisfaction.
- Decision confidence.
- Satisfaction with decision process.

- Participation perception.
- Communication satisfaction.
- Subjects commitment to the experiment.
- Competence of the experiment.
- Satisfaction with DGDSS software.

2. <u>Traditional</u>

The Traditional questionnaire was designed to gain information about the following:

- Case problem validity.
- Suitability of the case problem for a traditional setting.
- Decision satisfaction.
- Decision confidence.
- Satisfaction with decision process.
- Participation perception.
- Subjects commitment to the experiment.
- Competence of the experiment.

G. DECISION TASK

The case problem in this study was chosen because it presented the subjects with an unstructured problem of relatively high complexity for which no single right answer existed. The intention was that a solution to the problem would not be intuitively obvious to the decision maker.

The case problem was a two-part scenario beginning with a pre-scenario containing current media depictions of recent terrorist activities directed at the United States. The

second part was a scenario describing a terrorist attack on the Naval Postgraduate School and giving instructions to NPS decision makers to take part in a group decision session to develop a solution to the problem. A copy of the scenario is contained in Appendix B.

1. <u>Expert's Solution</u>

Since the scenario described a situation that involved property, personnel and policy of NPS, several staff members at NPS were given the case problem and treated as expert subjects for a final solution to the problem. Their method of prescribing a solution included previously established guidelines and policy for handling terrorist threat situations at NPS. The experts' solution was generated without the aid of the DGDSS system. A description of the experts' solution--assumptions and actions--are contained in Appendix C.

H. SUMMARY

This chapter gave a description of the physical design and session procedures for the DGDSS and traditional settings. The DGDSS program software operating concepts and theory of operation were discussed. Finally, a discussion of the decision problem and questionnaire evaluation concluded the chapter. In the following chapter we will show the results of the experiment, and discuss the analysis of our findings.

IV. RESULTS

A. INTRODUCTION

DGDSS test results were obtained from observations and data that were recorded during each group's decision making session and from the participant's responses to a post-session questionnaire. Since observations were made and recorded during the actual decision sessions and questionnaire responses were taken after the session, the results of each will be discussed separately.

B. OBSERVATION AND DATA

Throughout both the DGDSS and traditional sessions, the facilitator recorded observations of the group's progress in the decision process. The DGDSS group facilitator recorded notes on notebook paper while the traditional group facilitator used an observation form created prior to the session. A copy of the observation is included in Appendix D.

Since the traditional group facilitator had a very passive role in the decision session, the observation form enabled the facilitator to record time and individual group member's behavior, which included their participation (body attitude, facial expression, communication) in group discussion as well as the number of criteria and

alternatives they generated. A copy of the traditional session observation form is included in Appendix D.

The method of obtaining data from traditional and DGDSS decision sessions differed in that traditional groups were given a group solution form for recording the group's criteria, alternatives, and final solution. Data from DGDSS groups was obtained by recalling data files--created by the DGDSS program--after the session was completed.

Results of the observation and data collected will be discussed in three parts: Decision making process, Decision Time, and Criteria and Alternative Generation.

1. Decision Making Process

Of the six DGDSS and four traditional groups tested, only three of the DGDSS groups and all of the traditional groups arrived at a final decision. The failure of three DGDSS groups to reach a final solution was due to both time constraints and DGDSS software failure. Two of these three groups went beyond the two hours allocated for the session. Group members had prior commitments which prohibited them from continuing on to a final solution. The third group experienced DGDSS software failure immediately after submitting their scoring of alternatives to criteria results. While only one DGDSS group arrived at the experts' solution, none of the traditional groups did.

a. DGDSS

Observing the DGDSS decision making process was tedious. Software failure caused from program inflexibility when decision makers erred in their keystrokes became a regular occurrence in all DGDSS session. Additionally, as the decision makers progressed further in the decision session, the DGDSS program performance progressively slowed down. Although an exact measurement of this degradation in program performance time was not obtained, frustration was visually observed in decision makers, especially during the alternatives scoring phase.

Observations of subjects using electronic message sending revealed that when participants wished to send a message to all group members simultaneously, it was necessary to send the message to the facilitator, in an abbreviated form, for re-broadcasting. This was necessary because the user's DGDSS broadcasting capability failed to work. It was also observed that most the message traffic sent during sessions pertained strictly to the decision problem or decision process.

b. Traditional

In each group, one individual usually assumed the role of recorder for the group and another individual normally assumed the role of group leader. Although the group leader role was never formally determined in any of

the groups, each decision session had at least one individual who led the group through the decision process.

The most commonly observed body attitude, facial expression, and communication in each of the traditional decision sessions was "participating" (sitting up at the table speaking, or listening intently and preparing to be speak), "relaxed" (content, fulfilled, or in good spirit, calm), and "positive verbal" (participating in problem discussion, working with the group) respectively. Two groups were observed to break periodically from the problem discussion to joke around as a group.

Most groups appeared to use a step-by-step decision process establishing criteria first, then alternatives, and then re-establishing criteria and alternatives until a "specific set" (criteria and alternatives deemed by the group as most relevant to the problem) was determined by the group. Groups usually chose their final problem solution immediately after this set was established, which might lead us to assume that group members had decided on a solution before all criteria and alternatives were evaluated completely.

2. Decision Time

Both the DGDSS and traditional group sessions were timed from when the case study was presented to when the group either arrived at a solution or chose to end the session. All times recorded for both DGDSS and traditional

sessions were summed and divided by the number of sessions respectively to arrive at an average solution time for DGDSS and traditional decision session. The DGDSS groups averaged 105.7 minutes to reach a solution. This was twice the time required by the traditional groups, which averaged 52 minutes to reach a solution.

Although the exact reason for the significant difference in solution time between the two sessions is unknown, the following factors may have contributed: slow DGDSS program performance, inability of DGDSS members to broadcast messages, cumbersome structure provided by the DGDSS in the decision making process, anonymous--uninhibited input--provided by the DGDSS, participant's level of knowledge of the decision process for their respective settings, and traditional groups capability for verbal discussion.

3. Criteria and Alternative Generation

a. DGDSS

The criteria and alternatives generated during DGDSS sessions were saved in data files for later analysis. The criteria and alternatives were summed and then divided by the number of sessions to determine the average number of criteria and alternatives per session. DGDSS sessions averaged 9.75 criteria and 12.2 alternatives generated per DGDSS session.

b. Traditional

As mentioned earlier, the group's criteria, alternatives, and final solution were recorded on the solution form by one group member. The method used to find the average number of criteria and alternatives generated per group was the same as the one used above for the DGDSS observation. The results of the traditional group solution form showed that the average number of criteria and alternatives generated per group was 7.5 and 5 respectively.

To try to explain the difference in DGDSS and traditional criteria and alternative generation, the following theory is suggested: It is possible that a larger number of criteria and alternatives would have been generated by each traditional group but that the group used a "weeding-out" process in order to focus on what the group believed to be the most relevant.

It is evident that each of the DGDSS groups generated large numbers of criteria and alternatives. This is consistent with Gallupe's finding that "use of the system tended to enhance idea generation and heighten the groups awareness of multiple viewpoints." [Ref. 3:p. 291] Considering the large amount of alternatives and criteria, and the fact that anonymity and structured decision process encourages input generation, the DGDSS can potentially increase decision maker's participation, when compared to traditional settings.

C. RESPONSES TO THE QUESTIONNAIRE

Questionnaire responses were tabulated and normalized so that all responses reflected uniformly a seven-point Likert scale. The scale extremes, 1 and 7, represented extreme negative and extreme positive responses respectively. Furthermore, the scale used the midpoint, 4, as a neutral point on all questions. Comparisons between DGDSS and traditional settings were done using one-tail "t" tests, at $p < 0.05$ to test for significant differences in sample means.

Results of the questionnaire have been compiled and will be presented in the following areas: Case Validity, Case Suitability for DGDSS/Traditional Settings, Decision Satisfaction, Confidence and Commitment, Satisfaction with Decision Process, Participation, Communication Satisfaction, Competence of the Experiment, and Satisfaction with the DGDSS Software.

1. Case Validity

Case validity measured the ability of the case to present a problem to decision makers that was challenging but solvable. Care was taken to ensure that our case study had adequate task difficulty and realism (case validity). Lack of case validity was found to be an experimental design problem in Hughes and Webb's previous research [Ref. 23]. Case validity was determined by measuring three variables, case complexity, case realism, and how well the case

resembled an actual situation. Since both DGDSS and traditional settings evaluated the same case problem, an aggregate statistical description was used (Table 4.1).

TABLE 4.1

MEAN AND STANDARD DEVIATION FOR
CASE COMPLEXITY AND REALISM

Case Validity	Mean	SD
Complexity	4.917	1.538
Realism	4.583	1.538
Actual Situation	5.417	1.025

Subjects were asked to express their level of agreement with the following statements:

- Immediately after reading the case study, the correct solution was not intuitively obvious to me.
- This case study seems realistic to me.
- This case study could be an example of an actual decision making situation.

Case validity was determined to be more than sufficient for this experiment. Point values were summed and divided by the number of subjects to arrive at an aggregate score (mean) for each statement. Scores in Table 4.1 show that subjects slightly agreed (mean = 4.917) the solution was not obvious and generally tended to agree that the case was complex but solvable. Subjects slightly agreed (mean = 4.583) that the case study content was realistic. Subjects agreed (mean = 5.417) that the case scenario could

be an example of an actual decision situation. However, comments made by DGDSS subjects suggested they had difficulty visualizing themselves as participants in decisions of this nature. Of the DGDSS subjects, 13.6 percent commented that they lacked the expertise in security affairs to effectively address the case problem.

Although a case of greater complexity was considered for this study, authors felt that too much difficulty could overwhelm the subjects, making it difficult for them to arrive at a solution.

2. Case Suitability for DGDSS/Traditional Settings

Case Suitability refers to subjects' feelings about how well the case study was suited for the decision environment--distributed GDSS or traditional face-to-face. DGDSS and traditional subjects were asked the extent to which they agreed that the case lent itself well to their respective decision environments--DGDSS or face-to-face.

Traditional Subjects were significantly more likely to agree than DGDSS subjects (at $p < 0.05$) that the case was suitable for their group decision making environment. DGDSS subjects slightly disagreed (mean = 3.318 and traditional subjects slightly agreed (mean = 5.357) that the case was suited for group decision making with a distributed GDSS ($p = .0001$). See Table 4.2.

As mentioned earlier, our case study was a semi-structured crisis situation matching the description of

TABLE 4.2

MEANS AND STANDARD DEVIATIONS FOR CASE SUITABILITY

	DGDSS		TRADITIONAL		
	Mean	SD	Mean	SD	Prob.
Case Suitability	3.318	1.615	5.357	1.151	.0001

"high relationship, low task" presented by Suchan, Bui and Dolk [Ref. 17]. DGDSS subjects' comments add credence to the contention of Suchan, Bui and Dolk that subjects would gain little service from GDSS for high-relationship, low-task problems [Ref. 17:pp. 444-445]. DGDSS subjects (40.9 %) commented that DGDSS would be better used in situations where time was not a critical constraint. Considering that DGDSS subjects had past experience with traditional decision making and their comments concerning time critical situations, the following can be inferred: (1) group decision makers prefer having personal interaction for crisis decisions such as those required by the case study--safety of human life/time sensitive; and (2) the case would have been better solved face-to-face.

3. Decision Satisfaction/Confidence/Commitment

Also mentioned earlier, only three of six DGDSS groups arrived at a final solution--two groups ran out of time and one had a system failure. This reduced the sample

size from 22 to 11 for DGDSS questions concerned with a final decision/solution.

a. Decision Satisfaction

The level of group member decision satisfaction was determined by evaluating the extent to which subjects agreed with the following statements:

- My group devised a good solution to the case.
- I am satisfied with the final result derived from my group's inputs.

Additionally, subjects were asked how satisfied or dissatisfied they were with the quality of their group's solution.

There was not a significant difference in decision satisfaction between DGDSS and traditional groups. Table 4.3 shows that DGDSS subjects were more inclined than traditional subjects to agree that they had devised a good solution (mean = 5.000 and 4.500 ($p = .2121$) respectively). Although DGDSS and traditional subjects slightly agreed that they were satisfied with their final solution, DGDSS subjects showed slightly more satisfaction than traditional subjects (means = 4.929 and 4.455 respectively, $p = .2559$). DGDSS and traditional subjects were slightly satisfied (means = 5.143 and 4.818 respectively, $p = .2815$) with the quality of their final solution; however, traditional subjects were slightly more satisfied than DGDSS subjects.

TABLE 4.3

MEANS AND STANDARD DEVIATIONS FOR
DECISION SATISFACTION

	DGDSS		TRADITIONAL		
Decision Satisfaction	Mean	SD	Mean	SD	Prob.
Good Solution	5.000	1.612	4.500	1.454	.2121
Final Result	4.929	1.492	4.455	2.067	.2559
Quality	4.818	1.601	5.143	1.167	.2815

b. Decision Confidence

Subjects were asked to what extent they were confident that their group's solution was correct. There was no significant difference between the two groups at $p < 0.05$. Traditional and DGDSS groups indicated that they were, to some extent confident with the final decision (means = 4.857 and 4.636 respectively, p = .3349). However, traditional groups were slightly more confident than DGDSS groups. See Table 4.4.

TABLE 4.4

MEANS AND STANDARD DEVIATIONS FOR
DECISION CONFIDENCE

	DGDSS		Traditional		
	Mean	SD	Mean	SD	Prob.
Decision Confidence	4.636	1.567	4.857	1.167	.3449

This finding is consistent with Gallupe's for GDSS: "groups who used the GDSS were slightly less confident in the decision they had made compared to other groups." [Ref. 3:p. 219] Gallupe explains this response as reflecting "post-decision apprehension":

> Groups supported by the...GDSS...[tend] to generate more possible decision alternatives. They also [consider] those alternatives in more detail. Because of this condition, these groups [have] a more difficult choice to make, and once they [make] a decision, they [are] possibly less confident because of the number and quality of the choices. [Ref. 3:p. 291]

Although decision quality was not measured, "post decision apprehension" may apply to the DGDSS groups in this study since they were inclined to generate large quantities of information.

c. Decision Commitment

Decision commitment was measured in two ways; subjects were asked the extent to which they felt:

- committed to the group's solution.
- personally responsible for the correctness of the group solution.

Traditional subjects exhibited significantly more commitment than DGDSS subjects to the final decision. Traditional subjects were committed to some extent (mean = 5.357) to the final decision and DGDSS subjects again were not sure (mean = 4.364, p = .0117). Additionally, traditional subjects felt slightly more responsible for the correctness of the group's solution than DGDSS subjects.

Traditional subjects indicated that they felt, to some extent (mean = 5.0) responsible for the correctness of the solution, DGDSS subjects were not sure (mean = 4.364). Although the difference was not significant at $p < 0.05$, it was significant at $p < 0.10$ ($p = .0986$). See Table 4.5.

TABLE 4.5

MEANS AND STANDARD DEVIATIONS FOR COMMITMENT TO SOLUTION

	DGDSS		Traditional		
Commitment to Solution	Mean	SD	Mean	SD	Prob.
Resp. for Correct	4.364	1.120	5.000	1.240	.0986
Committed to Solution	4.364	1.206	5.357	0.842	.0117

Surprisingly, DGDSS groups expressed more agreement than traditional groups that they had devised a good solution, but less confidence in the decision. DGDSS groups also exhibited less willingness than traditional groups to commit to the decision. Lower levels of decision satisfaction and decision confidence account in part for their lower levels of commitment. The significance of these findings has implications about the future of DGDSS. If decision makers lack sufficient satisfaction, confidence, and commitment regarding group decisions, the decisions will not likely be implemented well--despite its quality. DGDSS design must guarantee favorable attributes and decision

maker sentiments such as decision satisfaction, decision confidence and commitment to the decision. Further research is needed to determine what factors contribute to decision satisfaction, confidence, and commitment.

4. Satisfaction with Decision Process

Subjects were asked the extent to which they agreed to the following statement:

- I am satisfied with the decision making process my group used to develop a final solution.

Traditional subjects' responses indicated significantly more satisfaction (p = .0190) than DGDSS with the decision process. Traditional subjects slightly agreed (mean = 5.143) that they were satisfied with the decision process. DGDSS subjects gave a neutral response (mean = 4.300). See Table 4.6.

TABLE 4.6

MEANS AND STANDARD DEVIATIONS FOR SATISFACTION WITH DECISION PROCESS

	DGDSS		Traditional		
Satisfaction with Decision Process	Mean	SD	Mean	SD	Prob.
Decision process	4.300	1.261	5.143	0.864	.0190
Efficiency	3.476	0.928	4.529	1.016	.0036
Coordination	3.905	0.944	4.929	0.616	.0005
Understandability	4.286	0.902	5.214	0.426	.0005
Fairness	4.857	0.573	5.214	0.579	.0406

Overall findings show that DGDSS groups were less satisfied with decision process than traditional groups. This is consistent with Gallupe's finding for GDSS: "GDSS support resulted in significantly lower level of satisfaction with the group decision making process." [Ref. 3:p. 291] To attempt to isolate reasons for subjects' responses, researchers addressed the areas of group process efficiency, coordination, understandability, and fairness. Table 4.6 shows that traditional subjects felt their decision process was significantly more:

- efficient: traditional/DGDSS means = 4.429/3.476
- coordinated: traditional/DGDSS means = 4.929/3.905
- understandable: traditional/DGDSS means = 5.214/4.286
- fairness: traditional/DGDSS means = 5.214/4.857

Traditional groups felt that their group decision process was neither efficient nor inefficient, or were unsure (mean = 4.429). In contrast, DGDSS groups believed their decision process was inefficient (mean = 3.476). Traditional groups felt their decision process was coordinated (mean = 4.929) but DGDSS groups felt their decision process was neither coordinated nor uncoordinated, or were unsure (mean = 3.905). Traditional groups felt their decision process was understandable (mean = 5.214) and DGDSS groups felt their decision process was neither understandable nor confusing (mean = 4.286). Both settings felt that their decision process was fair--providing equal

participation--(traditional mean = 5.214, DGDSS mean = 4.857), but responses were significantly higher for traditional subjects.

DGDSS groups gave significantly less favorable responses in all areas. Because of the highly structured process provided by the DGDSS, these responses were unexpected--particularly regarding efficiency and coordination. These negative responses were caused by problems that developed from use of DGDSS software (discussed in the following chapter on analysis of DGDSS software). DGDSS subjects comments indicated that waiting, caused by normal DGDSS program operation, and inability to effectively communicate or coordinate the session caused frustration and confusion. Other comments addressed software unreliability saying that the system "crashed easily" and "lacked features" such as editing, recalling of criteria and alternatives, message broadcasting, and input limiting, which explains lower evaluations for efficiency of decision process.

The DGDSS program also lacked speed and robustness necessary for instant feedback and aggressive decision-making, qualities that Jelassi and Beauclair say mark decision makers' expectations of a system [Ref. 16:p. 151].

Some participants commented that the DGDSS decision process encouraged generation of excessive criteria and alternatives which became progressively more difficult to

manage as the session continued. Although ranking was intended to reduce--for later phases of the decision process--the number of criteria and alternatives by excluding less desirable ones, this option was not used effectively; subjects preferred to retain the majority of their entries. Large numbers of criteria and alternatives slowed program operation and, if large enough, could bring the program to an apparent halt. As mentioned in the decision satisfaction evaluations, the large number of criteria and alternatives may also explain, in part, why DGDSS subjects were less committed and had less confidence with the final solution. A few DGDSS participants expressed their desire for qualities associated with personal interaction present in traditional settings and their dislike for the impersonal characteristics of DGDSS settings.

5. Participation

Subjects were asked to give their perceptions about group participation by indicating the extent to which they agreed with the following statement:

- Everyone in my group had an equal chance to participate.
- I gave information that helped solve the problem.

Table 4.7 shows that there was no significant difference in perception of equal participation among subjects at $p < 0.05$. Both traditional and DGDSS groups

TABLE 4.7

MEANS AND STANDARD DEVIATIONS FOR PARTICIPATION

	DGDSS		Traditional		
Participation	Mean	SD	Mean	SD	Prob.
Reflects my inputs	4.800	1.317	5.571	0.646	.0349
Equal Participation	6.053	1.353	6.071	1.592	.4250
I gave information	5.571	1.207	5.714	0.611	.3430

also agreed (means = 6.053 and 6.071 respectively) that they had equal chance to participate and perceived that they had given information (means = 5.571 and 5.714) to solve the problem.

Subjects were asked to what extent the final solution reflected their inputs. Traditional subjects felt significantly stronger (at $p < 0.05$) than DGDSS subjects that solutions reflected their inputs. Traditional subjects felt to a good extent (mean = 5.571) that the solution reflected their inputs, while DGDSS subjects only felt to some extent (mean = 4.800) that the solution reflected their inputs ($p = .0349$).

Other than traditional subjects' feelings that their solutions reflected their inputs, there was no significant difference in subjects' perceptions about participation. Both groups felt that they contributed to solving the problem and also that there was equal opportunity to participate in the decision process. However, DGDSS

subjects had more difficulty seeing the impact of their inputs on the final solution. This may have resulted from being unable to monitor the direct influence of their contributions on the decision session as traditional subjects could.

Facilitator observation revealed that traditional subjects dealt with issues rather than procedures. Issues were opened, discussed then closed or temporarily shelved for later discussion. Traditional subjects saw the reactions of other group members from the moment inputs were made to the forming of a consensus. On the other hand, DGDSS subjects made their inputs to the system and then quickly went on to other things, such as making more entries or browsing. DGDSS subjects could not be sure that others gave adequate consideration to their inputs. Additionally, calculations for scoring alternatives were not immediately observable to subjects. Subjects could not see the impact of their criteria weighing and alternatives scores on the final outcome.

6. Communication Satisfaction

Communication satisfaction was measured in three ways: method, quality and effectiveness of communication (Table 4.8). Subjects were asked to evaluate the adequacy of their communication method. Traditional subjects responded significantly more favorably ($p = .0001$) than DGDSS subjects. Traditional subjects felt that their method

TABLE 4.8

MEANS AND STANDARD DEVIATIONS FOR
COMMUNICATION SATISFACTION

	DGDSS		Traditional		
Comms. Satisfaction	Mean	SD	Mean	SD	Prob.
Method	3.636	1.787	6.071	0.829	.0001
Quality	3.810	1.365	5.929	0.730	.0001
Effectiveness	3.545	1.371	5.929	0.616	.0001

of communications was adequate (mean = 6.071) and DGDSS subjects felt that theirs was neither good nor bad (mean = 3.636).

Subjects were asked to evaluate the quality of their session communication. Traditional subjects responded significantly more favorably (p = .0001) than DGDSS subjects. Traditional subjects felt their session communication was of good quality (mean = 5.929) and DGDSS subjects felt that theirs was neither good nor bad (mean = 3.810).

Subjects were asked to evaluate the overall effectiveness of their groups communication. Again, traditional subjects responded significantly more favorably (p = .0001) than DGDSS subjects. Traditional subjects felt that communication was effective (mean = 5.929) and DGDSS subjects felt that communications were only partially effectively (mean = 3.545). See Table 4.8.

Aside from case suitability, the most significant difference between the two settings was exhibited regarding communication satisfaction. DGDSS subjects gave significantly less favorable assessments than traditional subjects in all three areas. The reason for this reaction can best be summed up by comments offered by DGDSS subjects:

- Inability to match messages with their appropriate replies.

- Inability to address messages to all members of the group simultaneously.

- Inability to simulate conversational discussion through message exchange.

- Electronic message sending was too slow and difficult.

- Message sending facility did not allow adequate space for clear communication to take place in one message.

Our findings highlight the importance of communications in the design of DGDSS features.

7. <u>Competence of the Experiment</u>

Subjects were asked how competently the facilitators had conducted the experiment. The difference in responses was significant at $p < 0.05$. Traditional subjects felt the experiment was smoothly executed, whereas DGDSS subjects felt the experiment was executed with slightly below average professionalism (traditional/DGDSS means = 4.786/3.773, $p = .0069$). See Table 4.9. The most significant contributor to this assessment was the temperamental quality of the software.

TABLE 4.9

MEANS AND STANDARD DEVIATIONS FOR
COMPETENCE OF EXPERIMENT

	DGDSS		Traditional		
	Mean	SD	Mean	SD	Prob.
Experiment Competence	3.772	1.066	4.786	1.251	.0069

8. Satisfaction with DGDSS Software

Software satisfaction was measured in terms of perceived usefulness, ease of use, how understandable the steps of operation were, frustration/confusion caused by using the software, and ease in learning to use the software. Table 4.10 gives the mean of responses given by DGDSS subjects.

TABLE 4.10

MEAN AND STANDARD DEVIATION FOR
SOFTWARE SATISFACTION

SW Satisfaction	Mean	SD
Usefulness	2.619	1.284
Ease of use	4.143	1.236
Understandability	4.143	1.558
Frustration free	3.619	1.396
Ease to learn	4.952	0.740

Software usefulness was measured by asking subjects if they would be willing to use the experimental version of the DGDSS again for other decision meetings. Responses

showed little desire to use the system for some decision meetings and that subjects would only use the system sometimes (mean = 2.619). However, this result was probably due to the temperamental nature of the software and the dissatisfaction with communications offered by the system. DGDSS subjects gave a neutral response in regard to the software's ease of use (mean = 4.143) and their ability to understand how to use it (mean = 4.143).

DGDSS subjects were asked how easy the DGDSS program was to learn. Subjects responses indicated that learning to use the system was easy (mean = 4.952).

When asked if they were frustrated by using the DGDSS program, subjects indicated that the software caused some frustration (mean = 3.619). Observations showed that subjects were often preoccupied with questions about the DGDSS-program operation and decision process--rather than the decision problem. This finding was similar to that of Watson, who determined that "groups became overly concerned with procedural matters" as opposed to the issues [Ref. 20:p. 474]. The current study's DGDSS subjects agreed that even though learning to use the system was easy, the software caused some frustration. Many of the comments on software performance addressed slow system operating speed (25%), lack of system capabilities (18.7%), and system unreliability (28%). These issues will be discussed in the following chapter on analysis of DGDSS software.

D. CONCLUSIONS

Results from the testing of the experimental prototype DGDSS software program on subjects in a simulated distributed geographical setting most definitely demonstrated that many improvements in the prototype would be needed before any further testing takes place.

Furthermore, both the observation and data as well as the questionnaire results proved the following:

- That the most desirable DGDSS user capability was the anonymity in information generation, while the most needed DGDSS user capabilities which were not provided were:

    * an artificial limitation on the number of criteria and alternatives generated.

    * enhanced editing to include criteria and alternative titles.

    * criteria description recall during the scoring phase, and enhanced communications to include message broadcasting.

- The design of the DGDSS disrupted the decision making process due to software slowness, an inadequate communication capability that also affected the ability to coordinate the decision process, unreliability of software, and lack of needed capabilities.

- The potential of the DGDSS to provide better decision quality cannot be ascertained by this study since half of the DGDSS groups never arrived at a solution.

- The DGDSS does have the potential to increase decision maker participation as demonstrated by the large average number of criteria and alternatives generated during the current study's DGDSS group testing.

- The experimental prototype DGDSS software will require many improvements in-order to be of assistance to decision makers in a distributed setting.

- Our DGDSS is of little assistance to decision makers faced with a problem having a time sensitive/critical and highly emotional nature to them.
- DGDSS decision groups were less committed to and less satisfied with the final group solution, less satisfied with the decision process, and less satisfied with the communications, than the traditional decision groups.

This chapter discussed the results of testing for DGDSS and traditional settings. The next chapter will discuss the significant strong points and weaknesses of the DGDSS software program used in this study.

V. ANALYSIS OF DGDSS SOFTWARE

To determine the potential usefulness of any newly developed DGDSS software, testing must be done to assess the benefits and problems associated with the software. Through this process, necessary improvements can be identified and incorporated into the DGDSS prior to system delivery to the customer.

As stated in the Introduction, the DGDSS software program used in this research is an experimental prototype. As demonstrated by the DGDSS users responses' to the questionnaire and the facilitator's observations of the DGDSS decision sessions, both beneficial qualities and annoying problems were discovered in the DGDSS software when conducting this research.

A. BENEFICIAL QUALITIES

The DGDSS software prototype offered many capabilities that proved to help users in the decision session. Those which had the greatest impact on the users were anonymity, menus, and user friendliness.

1. Anonymity

The DGDSS software enabled users to anonymously generate criteria and alternative input, rank the input, weigh the criteria, and score the alternatives with respect

to the criteria. This anonymity allowed all users to participate in the decision making process in a very uninhibited manner. As a result, numerous criteria and alternatives (when possible) were generated by the users in each DGDSS decision session conducted. The existence of peer pressure or a dominating group member was not apparent in any of the DGDSS sessions.

2. Menus and User Friendliness

The DGDSS software was created to be menu driven throughout the entire decision session. By doing so, users could move from one section of the decision session to another by using a few keystrokes. This capability reduced the need for extensive explanation on use of the DGDSS software, provided the user with an easy program structure to learn, and impressed the participants as a system that was user friendly.

B. PROBLEMS

Many problems with the DGDSS software were encountered by the research participants. As discussed in the Literature Review, when users have expectations about the software capabilities that are not met, frustration can occur which may result in less use of the GDSS. By uncovering this problem early in the development of the DGDSS, corrections can be made to either the software or the user's perception.

1. Slowness of Software

The DGDSS software was very slow. This problem progressively worsened as the decision makers proceeded through the decision making process. Group members commented on their frustration in waiting for the screens to change, delays in moving through menus, and length of time to obtain the calculated results of the session. An example of this problem was a DGDSS session that had four participants who collectively entered 15 criteria and 22 alternatives. Although through group consensus a cut-off on criteria and alternatives could be established after the ranking phase of each, participants chose not to impose one thus using all of the criteria and alternatives in the scoring phase. After the scoring phase of the decision making process, it took 40 minutes for the DGDSS software to compile and calculate a final group solution.

2. Communications

Users found the DGDSS' communications capability to be less then desirable and extremely cumbersome. Although a message sending and receiving capability was provided to each user, there was no ability to send one message simultaneously to all group members (broadcast). This required the user to either send out three identical messages or contact the facilitator and request that the facilitator broadcast the message to other group members. Obviously, the DGDSS communications slowed down the decision

process by increasing the time it took to communicate between decision makers.

The inadequate message sending capability coupled with the anonymous generation of input resulted in increased decision maker frustration when clarification of displayed information was needed. Instead of sending out identical messages to other group members, the decision maker either asked the facilitator to broadcast a message or used personal inferences to understand the information. In turn, each of these choices for obtaining clarification led to further problems.

By using the facilitator to relay messages, other message traffic to the facilitator had to wait, including messages of greater importance such as a participant getting stuck or being dumped out of the decision session by the software.

When the participants chose to clarify the information on their own, redundancy of generated criteria/alternatives occurred. Consequently, this created a catch-22 situation. Either decision makers would have to use the message system to discuss the combining of similar information or they could leave all the information intact which made the scoring of alternatives to criteria a long arduous process.

This is not to say that some of the criteria and alternatives could not have been eliminated during the

ranking phases by the establishment of a cut-off. The capability to eliminate criteria and alternatives below a chosen rank percentage was provided by the DGDSS. However, for decision makers to use this capability, a consensus by all group members had to be accomplished; and, the only way a consensus could be reached was by using the message system. Usually, by the time the decision makers had progressed to the point of ranking the criteria, they were thoroughly frustrated by the message system's limitations and preferred to just go on to the next phase of the decision process. By choosing to forego the opportunity to establish a cut-off, each group ended up with a large number of alternatives to rank against a large number of criteria.

3. Inflexibility

The DGDSS software provided very little flexibility to the group members. An example of this inflexibility was the system's reaction to a group member who entered an incorrect character while generating criteria or alternatives.

For a decision maker to add criteria or alternatives, he/she would enter the respective "Add" menu module and the screen would display a blank file card with a distinct header space for the title of the criteria/ alternative. The decision maker could only enter letters into this space. Any attempt to enter a number or special

character resulted in the software moving the decision maker to the space allocated for the criteria/alternative description regardless of whether the title of the criteria/alternative was completed on the file card. Complicating this problem was the editing capability of the software.

The decision maker could edit the title of the criteria/alternative only during the time it was being created and only by using the delete key. Attempting to use the backspace key caused the same results as using a special character key. After the criteria/alternative title was created, there was no way to edit it. This left the decision maker with three choices. He/she could ask the group for a consensus on having the criteria/alternative combined with another that was similar, or tell the group members to disregard it as a mistake, or attempt to clarify the title of the card in the space provided for the description.

Using this final choice for a mistake on a criteria title led to total confusion in the scoring phase. This occurred because the DGDSS software did not provide the capability to recall the criteria description when scoring the alternatives to the criteria. The inability to view criteria description frustrated the decision makers even further when they realized they had numerous criteria to deal with.

4. <u>Software Fragility</u>

Many times if the user hit the wrong key when trying to send a message or use the function keys, the DGDSS software would dump them out of the decision session. This resulted in the group member having to restart the program. This restarting sometimes inadvertently caused an additional problem of the user logging into the same decision session twice, which resulted in a total DGDSS software collapse during the next immediate compiling phase of the session. To restart the session, the facilitator had to go into the DGDSS software file containing the names of the decision makers for the respective session and delete the additional logged-in decision maker's name. Then all decision makers would have to restart the decision session.

In addition to the time delay in correcting this problem, all rankings or weights and scoring would have to be reentered by the group members on criteria, alternatives, or both, depending upon which decision making phase the DGDSS software crashed in. However, not all mistakes resulted in a group member crashing the DGDSS software or the user being dumped out of the decision session. There were incidents where a decision maker would get locked into a menu and the facilitator was able to correct the problem.

Another distressing situation was the inability of the DGDSS software to compile, calculate, and display ranks or scores with the group members remaining in the respective

menu. After group members' released their rankings or scores for compiling, it was necessary for them to "back-out" of the respective menu to the main menu. If any member failed to either release their ranks/scores or back-out of the module, the DGDSS crashed and required all decision makers to restart the session and reenter the ranking/ scoring.

Other observed problems with the DGDSS software included the following: no on-line "Help" capability, Function keys for Alternative "Comment" and "Note" capabilities being mislabeled, numerous typographical errors on the display menus, and limited character space for messages.

C. SOFTWARE IMPROVEMENTS

One of the questions that this study addresses is, if the DGDSS software can be improved to provide better assistance to decision makers in a distributed setting. We believe that it can be improved by correcting the software code and adding some additional capabilities. Recommended improvements for each software problem presented as well as other DGDSS decision making features will be discussed.

1. Communications

The communications component is one of the most important design capabilities in a DGDSS. This has been stated in previous research and is evident in the present

study. Necessary improvements to the DGDSS software communications component include providing the group decision makers with the ability to create longer messages and to broadcast messages.

It is difficult to predict what would be the best message space allocation in a DGDSS. The message space provided by this DGDSS was less then 120 characters. It was demonstrated both in the responses to the questionnaire and through observations by the facilitator that the prototype did not provide enough space for some of the decision makers to clearly express their thoughts in one message. In future versions of this DGDSS software, Message space should be expanded considerably, perhaps to an entire screen. By doing so, the decision maker will not have to waste time thinking about how they are going to abbreviate their thoughts to fit them into one message.

The message broadcasting capability is already built into the DGDSS prototype but was not used in this study by the group members. This was because it failed to work correctly and resulted in repeated "locking-up" of the software. At first the researcher felt this locking-up was due to group member inexperience because the facilitator had no problem broadcasting messages from his work station. So to check this theory, the facilitator attempted to broadcast a message from the user work-station which produced the same results experienced by the group member. This led the

researcher to believe the problem is in the user software coding of the broadcast capability. The problem should be correctable since the broadcast capability works in the facilitator's software.

2. Software Speed

There are many unknowns that may have caused the lack of speed in the software. An initial possibility is the coding of the software. Using mathematical algorithms that are inefficient would cause a slowness in calculating, but it would not explain the progressive slowdown of the software as the group members progressed through the decision session. It is possible that the languages used in coding are not efficient for a DGDSS application. Another possibility is that the network used in conducting this DGDSS research is inefficient. Regardless of the cause of the slowness, the speed of the DGDSS software must be improved immensely for this DGDSS prototype to have any potential future.

3. Flexibility

The inflexibility can be corrected by both altering the code and adding capabilities. The DGDSS software could be coded to not allow entry of a special character into the criteria/alternative title field without moving the decision maker to the description screen. This coding could incorporate sound to alert the decision maker of an incorrect entry.

The software could also be improved by providing the decision maker with the capability to review criteria description during the scoring phase. This capability could be built into a function key and would probably result in less decision maker frustration in the scoring phase, especially if faced with numerous criteria.

Providing the capability to go back and edit the criteria/alternative title may not be possible since it would allow a single decision maker to delete public information. Granted, the title was originated by the lone decision maker who would be able to edit it, but the title becomes public information once it is displayed to all group members. A limited editing capability should be made available to the decision maker for use prior to releasing the title for public display.

4. DGDSS Fragility

The fragility of the prototype can only be improved by both altering the software code and adding more capabilities. By making the software more robust, some of the time delays and user frustrations experienced in this study will be lessened in future studies. Furthermore, these improvements can make it possible to conduct a more in-depth study of how well this prototype assists the group decision makers throughout the entire decision making process.

The software should not be so fragile that a decision maker gets locked-up in the DGDSS trying to use a function key. This is probably a correctable error in coding. It should be unnecessary for all group members to have to back-out to the main menu for the software to do the calculations. This can also be corrected by altering the code.

Capabilities should be built into the software that would alert the facilitator when either a decision maker failed to release their rank/scores or a group member logged into the decision session twice.

5. <u>Additional Areas Where Improvements are Recommended</u>

The DGDSS software could also be improved by incorporating the capability to artificially limit the number of criteria and alternative that any one group member can input. This capability should be dynamic so that it can be turned off when the DGDSS decision making session requires unlimited brainstorming. Although this capability may provide similar results as the group using a consensus cut-off during the criteria/alternatives ranking phases, an artificial limit may prove to be more helpful if solution time is critical or the group members are known for being unable to arrive at a consensus.

Other recommended improvements to the DGDSS software are the creation of an on-line help facility, correction of typographical errors in the menus, the coding of the

function keys to provide identical capabilities throughout each phase of the decision process, and adding color to the displays.

To conclude, the experimental prototype DGDSS software program used in this study had both beneficial qualities and problems. The beneficial qualities discussed were user friendliness, menus, and anonymous information generation. Also discussed were the software problems which included execution slowness, inadequate communications capability, software inflexibility, and software fragility, as well as recommended software improvements which would eliminate all of the problems. Finally, additional areas for improvements were suggested. Through this evaluation of the experimental prototype DGDSS software used in the current study, it should be evident that although the prototype has the potential to assist decision makers in a geographically distributed decision making setting, the extent of the potential cannot be measured until the software improvements are made.

VI. CONCLUSIONS

A. DISCUSSION

This chapter summarizes the case study test results, the prototype DGDSS software evaluation results, and the significance of the test results and software evaluation in terms of the research questions proposed in the Introduction.

1. Case Study Test Results

To summarize, the case study tested two distinct groups of decision makers: four groups in a traditional face-to-face decision making setting and six groups in a simulated geographically distributed decision making setting. The task type used was crisis planning with a high degree of difficulty. Results of the case study testing were obtained through observation and data, and participant responses to a questionnaire. By combining these two methods, an accurate portrayal of the testing was obtained.

a. Observation and Data

The facilitator observations were made during each traditional and DGDSS group decision session. Additionally, the facilitator recovered data from DGDSS files and from traditional group solution forms. Through the observation and data, the following pertinent information was found:

- Traditional groups reached a solution twice as fast DGDSS groups.

- DGDSS groups generated a larger number of criteria/alternatives which they chose to keep through the scoring phase. In contrast, the traditional group generated a large number of criteria/alternatives but chose to limit the total number that would be submitted on the group solution form.

- DGDSS groups had many problems with the experimental prototype DGDSS software including limited communication capability, inflexibility, progressively decreasing software processing speed, and software fragility, all of which resulted in user frustration.

- Only three of the six DGDSS groups reached a solution, while all of the traditional groups reached a solution.

- Of the seven groups to reach a solution, only one of the DGDSS groups and none of the traditional groups reached the experts' solution; however, decision quality was not measured in this study.

b. Questionnaire Responses

Both the traditional and DGDSS groups were asked to fill out a questionnaire at the completion of their respective decision sessions. Questionnaire responses were tabulated to obtain the average response from all traditional and DGDSS group participants. The results of the questionnaire demonstrated the following:

- DGDSS members did not feel that the case problem scenario used was suitable for a geographically distributed decision making environment.

- DGDSS members that did reach a final solution were more satisfied than traditional group members with the final group solution.

- Traditional members were more committed to the group's final solution.

- Traditional members were more satisfied with the decision making process.

- Traditional members more readily agreed that the solution reflected their personal inputs.

- Both traditional and DGDSS group members felt that the ability to participate was fair, and that they personally offered information.

- Traditional members were significantly more satisfied with the communication in their decision making setting.

- DGDSS members had little desire to use the DGDSS software for other group decision meetings.

- DGDSS members were frustrated in using the DGDSS software.

c. Combined Testing Results

Combining the observation and data test results with the responses from the questionnaire clearly demonstrates that the experimental prototype DGDSS software hindered the groups' decision making process. Furthermore, since the DGDSS group had no choice but to rely on the prototype DGDSS software to reach a solution, it can be inferred that the DGDSS software used in this study severely inhibited the researchers' ability to accurately measure the potential of a DGDSS to assist in a geographically distributed group decision making process or its potential to improve decision quality.

2. Software Evaluation

The evaluation of the experimental prototype DGDSS software illustrated the beneficial qualities, problems, and recommended improvements.

a. Beneficial Qualities

The DGDSS did possess a few characteristics, anonymity, menus and user friendliness, that were viewed by the group decision makers as being very beneficial in the decision making process.

The ability of the DGDSS to provide anonymous information generation allowed the decision makers to enter criteria, alternatives, ranks, weights, and scores anonymously. Many decision makers felt this enhanced their ability to participate in the group decision making process since it allowed them to be less inhibited about the information they offered to the group.

The DGDSS provided a menu driven program that allowed group members to move from one phase of the decision making process to another through the use of a few keystrokes. Group members found this to be very helpful since it made learning the DGDSS operation very easy. Consequently, this ease of learning the DGDSS operation left the decision makers with the feeling that the software was very user friendly.

b. Problems

The DGDSS software had many major problems, including slowness, limited communications, inflexibility, and fragility.

- As the decision making process progressed, the DGDSS processing speed progressively declined.

- The communication component did not allow decision makers to broadcast messages or offer adequate space to the decision maker to send out a message without abbreviating the message content.

- The software did not allow users to make keystroke mistakes, edit in certain areas, or recall criteria descriptions during the scoring phase.

- The software was so fragile that decision makers could get dumped out or locked out of the decision making process for minor keystroke mistakes. Additionally, an error by a decision maker trying to reenter the decision making process or failure of a decision maker to release ranks, scores, and weights, caused the software to crash.

c. Recommended Improvements

Improvements to the DGDSS were suggested in all of the problem areas presented above. Most of the improvements will require a correction of the DGDSS software code, while other improvements will require the addition of capabilities not presently offered in the experimental prototype DGDSS software, including increased message writing space, enhanced editing, unlimited description recall, and on-line help facility. Additionally, it was recommended that all typographical errors in the menus and mislabled functions be corrected. Consequently, it was evident that all problems with the DGDSS software could be corrected through code corrections or system enhancements.

3. Significance to the Research Questions

In the Introduction chapter, the following research questions to be answered by this study were presented:

- Which DGDSS user capabilities are most desirable?
- Which DGDSS user capabilities are most needed?
- Does the design of the DGDSS enhance or disrupt the decision process?
- Does the DGDSS have the potential to provide better decision making quality and increased decision maker participation?
- Can the DGDSS be improved to provide better assistance to decision makers in a distributed setting?

Although the test results and software evaluation demonstrate many shortcomings in the experimental prototype DGDSS software, answers to many of the research questions are provided as follows.

The most desirable DGDSS user capability is the anonymity in information generation, while the most needed DGDSS user capabilities are: an artificial limitation on the number of criteria and alternatives generated, enhanced editing to include criteria and alternative titles, criteria description recall during the scoring phase, and enhanced communications to include message broadcasting and adequate message space.

The design of the experimental prototype DGDSS disrupted the decision process due to software slowness, an inadequate communication capability that also affected the ability to coordinate the decision process, unreliability of software, and lack of needed capabilities.

The potential of the DGDSS to provide better decision quality cannot be ascertained by this study since half of the DGDSS groups never arrived at a solution.

The DGDSS does have the potential to increase decision maker participation as demonstrated by the large average number of criteria and alternatives generated during the current study's DGDSS group testing.

The experimental prototype DGDSS software will require many improvements in order to be of sufficient assistance to decision makers in a distributed setting.

B. CONCLUSION

Although the experimental prototype DGDSS software used in this study limited the ability to obtain general and all-encompassing answers to the DGDSS research questions purposed, it did provide valuable information on DGDSS design mistakes that can alter future DGDSS study attempts and severely cripple any possible implementation of the DGDSS into the business sector. Furthermore, it needs to be restated that the experimental prototype DGDSS software used is correctable and must be improved before any future geographically distributed decision session studies are conducted.

Finally, under different circumstances, such as incorporation of better DGDSS software incorporated, less time sensitive decision problem, and more decision maker

experience in the problem faced, a DGDSS can be of assistance to group decision makers in a geographically distributed setting. However, further research on the DGDSS is recommended to measure the level of the assistance.

APPENDIX A

QUESTIONNAIRE

The following questionnaires were used for DGDSS and Traditional Sessions.

QUESTIONNAIRE: GDSS

(Adapted from Hughes and Webb, Watson)

BACKGROUND INFORMATION

Please answer the following questions.

1. Age ________ years

2. Sex: __ F __ M (check one)

3. Branch of service: __ Navy __ Marine __ Army

   __ Coast Guard __ Air force

4. Number of years in service _______ years

5. Rank ___________

6. Your level of experience with working in groups (circle one)

1	2	3	4	5
Very High	High	Medium	Low	Very Low

7. Your level of experience making actual business/military decisions (circle one)

1	2	3	4	5
Very High	High	Medium	Low	Very Low

8. Your level of experience using computer systems

1	2	3	4	5
Very High	High	Medium	Low	Very Low

SESSION

Please respond to the following statements by **circling** the response that best matches your feelings toward the statement.

1. Immediately after reading the case study, the correct solution **was** intuitively obvious to me.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

2. This case study could be an example of an actual decision making situation.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

3. This case study seems **unrealistic** to me.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

4. This case lends itself well to a **Distributed** GDSS decision environment.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

5. I am satisfied with the number of **alternatives** my group identified.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

6. I am **satisfied** with the number of **criteria** my group identified.

1	2	3	4	5	6	7
Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

7. This Distributed GDSS software program is **helpful in structuring** my thoughts.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

8. My group devised a **good solution** to the case.

1	2	3	4	5	6	7
Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

9. I am **dissatisfied** with the decision making **process** that my group underwent to develop a solution.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

10. I am satisfied with the **final result** derived from my groups' inputs.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

11. The **method for communicating** with other group members was

1	2	3	4	5	6	7
Unsatis-factory	Inadequate	Marginally bad	Neither good nor bad	Marginally good	Adequate	Satisfactory

12. I feel personally responsible for the correctness of the group solution?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

13. To what extent does the final solution **reflect your inputs**?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

14. To what extent are you **confident** that the group solution is correct?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

15. To what extent do you feel **committed** to the group's solution?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

16. How satisfied or dissatisfied are you with the **quality** of your group's solution?

1	2	3	4	5	6	7
Very Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neither	Slightly Satisfied	Satisfied	Very Satisfied

17. **Not everyone** in my group had an equal chance to participate.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

18. The over all **quality** of the session **communication** was

1	2	3	4	5	6	7
Very Good Quality	Good Quality	Adequate Quality	Neither Good nor Bad	Barely Acceptable	Poor Quality	Very poor Quality

19. The communication, on the whole, was

1	2	3	4	5	6	7
Very Effective	Effective	Partially Effective	Neither	Partially Ineffective	Ineffective	Very Ineffective

20. The decision **session** was

1	2	3	4	5	6	7
Incompetently Executed	Clumsily Executed	Awkwardly Executed	Averagely Executed	Smoothly Executed	Competently Executed	Professionally Executed

21. The group members submitted **inputs on** issues that were

1	2	3	4	5	6	7
Totally Relevant	Mostly Relevant	Partly Relevant	Not Sure	Partly Irrelevant	Mostly Irrelevant	Totally Irrelevant

22. The **interpersonal** relationships among the participants **appeared** to be

1	2	3	4	5	6	7
Very Unhealthy	Unhealthy	Weak	Not Important	Firm	Healthy	Very Healthy

23. **My interest** wandered during the group's decision making process.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

24. I **gave information** to help solve the problem.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

25. I was **not receptive** to others' inputs.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

26. How would you describe your group's problem solving process?

a.

1	2	3	4	5	6	7
Extremely Efficient	Very Efficient	Efficient	Unsure/ Neither	Inefficient	Very Inefficient	Extremely Inefficient

b.

1	2	3	4	5	6	7
Extremely Coordinated	Very Coordinated	Coordinated	Unsure/ Neither	Un-Coordinated	Very Un-Coordinated	Extremely Uncoor-dinated

26. (cont.)

c.

1	2	3	4	5	6	7
Extremely Under-Standable	Very Under-Standable	Under-Standable	Neither	Confusing	Very Confusing	Extremely Confusing

d.

1	2	3	4	5	6	7
Extremely Fair	Very Fair	Fair	Unsure or Neither	Unfair	Very Unfair	Extremely Unfair

e.

1	2	3	4	5	6	7
Extremely Satisfying	Very Satisfying	Satisfying	Unsure or Neither	Dis-Satisfying	Very Dis-Satisfying	Extremely Dis-Satisfying

27. **Would you use** this experimental version of the computer system for group meetings?

1	2	3	4	5	6	7
Never	Seldom	Sometimes	Unsure	Often	Almost Always	Always

28. How **easy to use** was this experimental version of the computer system?

1	2	3	4	5	6	7
Impossible To use	Very Difficult	Difficult	Neither	Easy	Very Easy	Effortless To use

29. I found the **sequence of steps** for operating this experimental version of the GDSS program to be

1	2	3	4	5	6	7
Totally Confusing	Un-clear	Slightly Un-clear	Neither	Slightly Under-standable	Under-standable	Clearly Under-standable

30. The **amount of frustration** caused by using this GDSS program was

1	2	3	4	5	6	7
None at all	Almost None	Very little Frustration	Unsure	Some Frustration	Significant Frustration	Total Frustration

31. **Learning to use** this GDSS program was

1	2	3	4	5	6	7
Extremely easy to learn	Very easy to learn	Easy to learn	Neither	Hard to learn	Very hard to learn	Extremely hard to learn

OVERALL IMPRESSION

32. What factor, if any, would you say inhibited and/or encouraged your generation of inputs?

33. Was this GDSS application program **user-friendly**? Why or Why not?

34. In what kind of decision making situation would you find this GDSS application program most useful?

35. **Briefly list** any **annoying**, or **beneficial qualities** of the GDSS **software program** or **GDSS decision** session. (use bullets to save time).

Comments:

QUESTIONNAIRE: NON-GDSS
(Adapted from Hughes and Webb, Watson)

BACKGROUND INFORMATION

Please answer the following questions.

1. Age _________ years

2. Sex: __ F __ M (check one)

3. Branch of service: __ Navy __ Marine __ Army

   __ Coast Guard __Air force

4. Number of years in service ________ years

5. Rank ____________

6. Your level of experience with working in groups (circle one)

1	2	3	4	5
Very High	High	Medium	Low	Very Low

7. Your level of experience making actual business/military decisions (circle one)

1	2	3	4	5
Very High	High	Medium	Low	Very Low

8. Your level of experience using computer systems

1	2	3	4	5
Very High	High	Medium	Low	Very Low

SESSION

Please respond to the following statements by **circling** the response that best matches your feelings toward the statement.

1. Immediately after reading the case study, the correct solution **was** intuitively obvious to me.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

2. This case study could be an example of an actual decision making situation.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

3. This case study seems **unrealistic** to me.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

4. This case lends itself well to a **Face-to-Face** decision environment.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

5. **I am satisfied** with the number of **alternatives** my group identified.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

6. I am **satisfied** with the number of **criteria** my group identified.

1	2	3	4	5	6	7
Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

7. This **Face-to-Face** group decision setting is **helpful in structuring** my thoughts.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

8. My group devised a **good solution** to the case.

1	2	3	4	5	6	7
Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

9. I am **dissatisfied** with the decision making **process** that my group underwent to develop a solution.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

10. I am satisfied with the **final result** derived from my groups' inputs.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

11. The **method for communicating** with other group members was

1	2	3	4	5	6	7
Unsatis-factory	Inadequate	Marginally bad	Neither good nor bad	Marginally good	Adequate	Satisfactory

12. I feel personally responsible for the correctness of the group solution?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

13. To what extent does the final solution **reflect your inputs**?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

14. To what extent are you **confident** that the group solution is correct?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

15. To what extent do you feel **committed** to the group's solution?

1	2	3	4	5	6	7
Not at all	Almost Nil	To a small extent	Not Sure	To some extent	To a good extent	To a great extent

16. How satisfied or dissatisfied are you with the **quality** of your group's solution?

1	2	3	4	5	6	7
Very Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neither	Slightly Satisfied	Satisfied	Very Satisfied

17. **Not everyone** in my group had an equal chance to participate.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

18. The over all **quality** of the session **communication** was

1	2	3	4	5	6	7
Very Good Quality	Good Quality	Adequate Quality	Neither Good nor Bad	Barely Acceptable	Poor Quality	Very poor Quality

19. The communication, on the whole, was

1	2	3	4	5	6	7
Very Effective	Effective	Partially Effective	Neither	Partially Ineffective	Ineffective	Very Ineffective

20. The decision **session** was

1	2	3	4	5	6	7
Incompe-tently Executed	Clumsily Executed	Awkwardly Executed	Averagely Executed	Smoothly Executed	Competently Executed	Professionally Executed

21. The group members submitted **inputs on issues** that were

1	2	3	4	5	6	7
Totally Relevant	Mostly Relevant	Partly Relevant	Not Sure	Partly Irrelevant	Mostly Irrelevant	Totally Irrelevant

22. The **interpersonal** relationships among the participants **appeared** to be

1	2	3	4	5	6	7
Very Unhealthy	Unhealthy	Weak	Not Important	Firm	Healthy	Very Healthy

23. **My interest** wandered during the group's decision making process.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

24. **I gave information** that helped solve the problem.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

25. I was **not receptive** to others' suggestions and opinions.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

26. How would you describe your group's problem solving process?

a.

1	2	3	4	5	6	7
Extremely Efficient	Very Efficient	Efficient	Unsure/ Neither	Inefficient	Very Inefficient	Extremely Inefficient

b.

1	2	3	4	5	6	7
Extremely Coordinated	Very Coordinated	Coordinated	Unsure/ Neither	Un-Coordinated	Very Un-Coordinated	Extremely Uncoor-dinated

c.

1	2	3	4	5	6	7
Extremely Under-Standable	Very Under-Standable	Under-Standable	Neither	Confusing	Very Confusing	Extremely Confusing

d.

1	2	3	4	5	6	7
Extremely Fair	Very Fair	Fair	Unsure or Neither	Unfair	Very Unfair	Extremely Unfair

26. (cont.)

e. 1	2	3	4	5	6	7
Extremely Satisfying	Very Satisfying	Satisfying	Unsure or Neither	Dis-Satisfying	Very Dis-Satisfying	Extremely Dis-Satisfying

OVERALL IMPRESSION

27. What factor, if any, would you say inhibited and/or encouraged your generation of inputs?

Comments:

APPENDIX B

CASE PROBLEM

The North Koreans have voiced repeatedly their desires for a reunification of North and South Korea. They have consistently requested a withdrawal of all American troops from South Korean soil and all American influence in Korean affairs terminated. A growing number of South Koreans, particularly students, have become sympathetic to North Korean concerns. Rhetoric concerning the American presence and influence in South Korea has been increasing lately in South Korea, instigating disturbances by young South Korean students. These disturbances have become more numerous as well as increasingly more violent. Additionally, the students have focused their violence on Americans and their families working in South Korea. To complicate matters, a South Korean terrorist group has illegally crossed the borders into the United States and has systematically conducted terrorist activities against various targets including:

- The bombing of the Hydroelectric building at the Western division of the Morton Thyacol plant. Knowledge of the planned bombing was discovered through security sources. When company officials attempted to evacuate the plant, the terrorists detonated a bomb which damaged the building. There were no injuries or deaths reported in this incident. It is believed that the bomb was detonated by remote control. The terrorists were never apprehended.

- The taking of five hostages and subsequent damage to a School of Engineering building at Stanford University. One terrorist was killed, two people were injured, and the building sustained heavy damage. Negotiations with the terrorist were attempted but failed. When the time given by the terrorist for demands to be met had arrived and the demands were not met, a bomb was detonated. The terrorist had demanded the release of fellow terrorists confined in Soledad, and safe passage from the hostage area. Four terrorists were arrested.

- The destruction of an explosives experimentation building at the Teledyne-McCormick plant in Hollister. Six terrorists disguised as workers infiltrated the plant and attempted to steal various parts used for constructing explosives. It is believed that they had planted the bombs prior to the attempted burglary, but there is a remote possibility that at least one bomb was being carried by a terrorist. It is further believed that the terrorists detonated their bombs after seeing FBI and CIA agents arrive at the plant, possibly thinking they had been discovered (the agents were actually arriving to attend a meeting). It is not believed that the terrorist attack had any connection with the meeting. Aside from losing the building, two people were killed, including one terrorist; six others were injured. No terrorists were apprehended.

It is believed that the South Korean terrorist group knows the identities of many of the CIA and FBI agents working in the United States. This group is considered to be extremely dangerous, intelligent and calculating. It is assumed that they professionally case target areas for weeks prior to striking, leaving little to chance. It has been reported through reliable security channels that the group now has the capability to build a small nuclear bomb. The members of this group will not hesitate to sacrifice their own lives in their endeavors. This group has no known long term goal, like other terrorist groups.

SCENARIO

A. DGDSS INTRODUCTION

It is Wednesday, 0915, and you have been told to immediately go to a nearby computer network (that links the station) in the building you are in. Upon entering the network, you are instructed to "standby for a message from the Admiral." While you wait, you realize that three other students have also entered the network. Finally a message comes across the network from the Admiral. He informs all four of you that a potential disaster is in the making which, if not handled correctly, will result in grave consequences. He further informs the four of you that Washington (after reviewing your service records) has identified your group as the most qualified to handle this situation given the circumstances. Realizing that each member of your group is located in a different building, and that calling all of you in for this meeting may stir up attention prematurely, the Admiral directs you and your group members to use the network for decision making.

B. TRADITIONAL INTRODUCTION

It is Wednesday, 0915, and you have been told to report to the Admiral's office ASAP. Upon the arrival of you and your fellow group members, the Admiral states that a

potential disaster is in the making which if not handled correctly will result in some grave consequences. He further informs the four of you that Washington (after reviewing your service records) has identified your group as the most qualified to handle this situation given the circumstances.

C. PROBLEM

A group of at least five and possibly as many as ten South Korean terrorists have infiltrated NPGS. Their demands, if any, are unknown at the present time. They have not formally contacted any officials. Their presence was determined by the discovery of a dummy bomb at 0830 this morning, located at the station steam plant. A note attached to the bomb reads as follows:

> There are more bombs on this station. The difference is that the others are real and may be detonated. Any attempt to contact and bring aboard, for assistance in this situation, the FBI, CIA, SWAT Team, Police, Special Forces from Ft. Ord will automatically result in the detonation of the bombs. Any attempt to evacuate the station will result in the automatic detonation of the bombs. If we do not achieve our purpose and/or we decide it is the best way to get your government's attention, we will not hesitate to detonate the bombs. This is the only bomb you will find easily. You will not have enough time to find the others!"

D. WHAT IS KNOWN

- Pictures of all South Korean terrorist group members that are known will be telefaxed to the station by 0940.

- The weather is beautiful with a 20 MPH Southeasterly wind.

- The terrorists are disguised as South Korean NPGS students.

- Evacuating the station without automobiles will take at least an hour; with autos closer to two hours.

- There are 59 South Korean students at NPGS.

- All Security agencies are standing by, ready to assist at various locations around Monterey. They are in contact with the Admiral by phone.

- All NPGS military staff personnel are standing by, ready to assist. There are 104 officers and 86 enlisted.

- NPGS Security department (24 personnel) and Fire Department (18 personnel) are standing by ready to assist.

- If a nuclear bomb the size of three books was detonated, it could possibly destroy a two-three square block area.

It is assumed that terrorist members are watching the station. You know that they want something.

E. TASK

GIVEN THIS INFORMATION, THE PAST INFORMATION ON THE TERRORISTS AND THE ADJOINING INFORMATION ON POPULATION AREAS AND SECURITY AREAS:

- WHAT IS THE CRITERION (CRITERIA) THAT MUST BE CONSIDERED?

- WHAT ALTERNATIVES ARE AVAILABLE?

- WHAT ONE COURSE OF ACTION (A SOLUTION TO THE PROBLEM) SHOULD YOUR GROUP TAKE?

APPENDIX C

EXPERT SOLUTION

A. ASSUMPTIONS

- The bomb will be detonated. This has already been shown through their previous actions. Therefore, we must act on the premise that we're working against time. We can't sit and do nothing. If we at least do something, we stand a chance of finding the bomb and defusing it. If we do nothing, we lose.

- We know we will not be able to meet their demands whatever they are. We know there is no negotiating with them.

- We believe they want media attention.

- There are two common threads with the targets they have already hit. One: all three places are heavily involved with military contracts. Two: all three places have been involved with some aspect of the space program. Given this information we would start to look for the bomb in Halligan and Spanagel Halls.

- Our primary objective is to save lives.

B. ACTIONS

- Close the base. Do not let anyone enter. Evacuate all buildings by sounding fire alarms in each building. Immediately evacuate all civilians (except Fire Department and Base Police, all students, and all military staff personnel (not involved in assisting with the evacuation) via foot from the base.

- Use Fire Department to assist in rapid building evacuation.

- Use O-4's and O-5's to direct people to the nearest gate.

- Use Auxiliary Security force to man the gates to let people exit and to ensure that no one enters the base.

- Have Base Police identify and detain all Koreans. Escort Koreans off the base via bus and hold them in pre-arranged location on Fort Ord where they will be interrogated by the CIA.

- Public Works Officer arranges to have keys taken off base and give to EOD team.

- All remaining personnel evacuate the base.

- Call in the SWAT and EOD teams from Fort Ord. Enter base after all personnel have evacuated the base. Use to search for bomb. Start the search in Halligan and Spanagel Halls.

- Contact Monterey Police Department and Sheriff's Department to let them know what we are doing. Have them evacuate surrounding neighborhoods and cordon off those areas to ensure no one enters.

- Station Auxiliary Security force and Base Police two-three blocks away from the Base to assist Monterey Police in keeping people out of the area and to keep base secure.

- Contact California Highway Patrol to stop all traffic on Highway One.

APPENDIX D

OBSERVATION FORM

Start Time____ Group____ Date____ Finish Time____

P1____Time____

Body Posture:

____

Facial Expression:

____

Communication:

____

Number Generated:

Criteria_____________Alternatives__________________

P2____Time____

Body Posture:

____

Facial Expression:

____

Communication:

____

Number Generated:

Criteria_____________Alternatives__________________

P3_____ Time____

Body Posture:

____

Facial Expression:

____

Communication:

____

Number Generated:

Criteria_____________ Alternatives__________________

P4____ Time____

Body Posture:

____

Facial Expression:

____

Communication:

____

Number Generated:

Criteria_____________ Alternatives__________________

Group Time____

Progress:____

KEY

Body Posture	Facial Expression	Communication	Group Progress
(P) Participating	(A) Agitated	(PV) Positive Verbal	(D) Deliberating
(D) Defensive	(S) Stoical	(NV) Negative Verbal	(B) Brainstorming
(R) Relaxed	(R) Relaxed	(AL) Active Listening	(V) Voting
(B) Bored	(B) Bored	(I) Inattentive	(S) Stagnated
(A) Anxious	(RB) Rude Behavior	(W) Writing	
		(R) Reading	
		(D) Discussion	

EXPLANATION OF KEY OBSERVATION POINTS

Body Posture:

Positioning and general carrying of the body as a whole.

Participating:

Speaking, listening intently, or preparing to speak.

Defensive:

Angry, arms crossed, could be sitting forward or back, rigid.

Relaxed:

Attentive, calm, posture may be slack but not sloppy.

Bored:

Sitting back, looking at hands or around the room, sloppy posture.

Anxious:

Tapping foot or fingers, shaking foot, watching clock.

Facial Expression:

The expression on the face, the calmness, tenseness, or lack of.

Agitated:

Upset, disturbed, frustrated.

Stoical:

Indifferent of emotion, impassive, no change in expression to display feelings.

Relaxed:

Content, in good spirit, calm.

Bored:

Uninterested, apathetic.

Communication:

How participant interacts group.

Positive Verbal:

Participating in problem discussion, working with the group.

Negative Verbal:

Discussion other then the problem, irrelevant remarks.

Inattentive:

Not paying attention to the discussion, watching the clock.

Rude Behavior:

Private discussion, deliberate exclusion of others, etc.

Writing:

Recording personal or group thoughts on paper or chalkboard.

Reading:

Reviewing the problem or aspects of the problem.

Group Progress:

Phase of decision process where group is at any given time.

Deliberating:

Reviewing, stumped, confused.

Brainstorming:

Throwing out thoughts on criteria alternatives or facts.

Voting:

Agreeing/disagreeing on a specific set of criteria, alternatives, reaching a solution.

Stagnated Discussion:

Joking around, not working on problem.

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NCS, P.O. Box 22
FPO, New York 09571 2

Thesis
C48073 Clark
c.1 Experimental research
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